FLIGHT SAFETY FOUNDATION
Aviation Mechanics Bulletin

MARCH–APRIL 1999

Monitoring Aircraft-tire Pressure Helps Prevent Hazardous Failures

FLIGHT SAFETY FOUNDATION
1947–1999

FLIGHT SAFETY FOUNDATION

Aviation Mechanics Bulletin

Dedicated to the aviation mechanic whose knowledge, craftsmanship and integrity form the core of air safety.

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March–April 1999 **Vol. 47 No. 2**

Subscriptions: US$35 (U.S.-Canada-Mexico), US$40 Air Mail (all other countries), six issues yearly. • Include old and new addresses when requesting address change. • Flight Safety Foundation, 601 Madison Street, Suite 300, Alexandria, VA 22314 U.S. • Telephone: +1 (703) 739-6700 • Fax: +1 (703) 739-6708

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Monitoring Aircraft-tire Pressure Helps Prevent Hazardous Failures

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FSF Editorial Staff

The first lines of defense against catastrophic failures of aircraft tire/wheel assemblies are tire-pressure measurement by maintenance technicians and preflight inspections by flight crews. Despite the increasing reliability and accuracy of pressure-and-temperature sensors and warning systems installed on newer aircraft, such systems provide only safety redundancy and early warning of problems between routine checks. Aircraft tires perform reliably so often that complacency may develop in tire-pressure inspection and adherence to proper inflation/deflation procedures. Nevertheless, the potential consequences of failure are such that every effort should be expended to prevent tire-pressure problems.

Tire/wheel assemblies for most transport-category aircraft provide a cushion of compressed nitrogen that supports the weight of the aircraft on the ground; a mechanism for controlling the aircraft during taxi, takeoff and landing; and traction for braking. Correct tire-pressure maintenance is a key factor that enables tire/wheel assemblies to perform reliably under high static loads and dynamic loads.

These loads at takeoff speeds and landing speeds generate high centrifugal forces that produce stress and wear in tires. Nevertheless, the most detrimental factor affecting tire performance is excessive heat generation, according to tire manufacturers' tests. Heat generation in aircraft tires typically exceeds all other types of tires. As tires rotate, heat is generated by friction during tire deflection and by tread-surface oscillations (traction wave) caused by distortion of tires resuming their normal shape after deflection. (Tire deflection is the change in height from the axle to the ground when a tire is installed on an aircraft. Aircraft tires typically are designed for a deflection of 32 percent — 35 percent for some tires — approximately twice as much as tires on cars and trucks.)[1]

Correct tire inflation is essential in assuring that tires can withstand the centrifugal forces and heat of normal operations, with an adequate margin of safety for unusual operating conditions such as rejected takeoffs and hard landings.

The airframe manufacturer's procedures, as adopted by the operator, typically show the correct inflation pressure for each tire on a tire/wheel assembly when it is installed on the airplane, as well as correct removal/installation procedures. Maintenance technicians should note whether "loaded" or "unloaded" inflation pressures have been specified. If unloaded pressure has been specified, the pressure actually used for the tire under load must be computed by multiplying the unloaded-pressure value by 1.04.[2]

Serious Consequences Linked to Incorrect Tire Pressure

Deviations from approved tire-pressure maintenance practices can have serious consequences. Low tire pressure has been cited as a causal factor in some accident-investigation reports (in many incident reports, causal factors have not been specified).[3] Nevertheless, consequences of inadequate tire maintenance have ranged from separation of tire/wheel assemblies from aircraft on the ground, sometimes damaging nearby buildings and vehicles, to wheel-well fires and in-flight loss of aircraft control. Tire/wheel-assembly failures on aircraft also have been reported during pushback, and tire-tread delaminations have occurred on takeoff, with various degrees of 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 linked to tire pressure:

- The report of a July 1991 accident involving failure of tires on a McDonnell Douglas DC-8-61 during takeoff from Jeddah, Saudi Arabia, said, "The aircraft departed with underinflated tires.

During takeoff, two tires failed and ignited. After takeoff, the gear was retracted and fire was introduced into main gear wells. A series of system failures followed. … The aircraft structural integrity or control was lost on short final." Fourteen crewmembers and 247 passengers were killed in the accident; the aircraft was destroyed.

- The report for a March 1990 U.S. incident involving a tire failure that destroyed two tires of a McDonnell Douglas DC-9-30 during takeoff from Atlanta, Georgia, U.S., said, "The operator's daily service inspection requires that tire pressure be checked with a tire gauge. Two additional blown tires occurred during takeoff from the same operator's station within three months. Evidence of tire underinflation was discovered after the third incident."

Authorities Recommend Correct Tire Pressure For Each Flight

As a general rule, the major manufacturers of tires recommend a daily cold-tire inflation-pressure check and maintenance of a written record. This check should include measurement of pressure with a calibrated hand-held gauge, noting ambient temperature. ("Cold tire" refers to a tire at approximately the same temperature as the surrounding air, typically after a postflight cooling period of two hours to three hours. By comparison, manufacturers typically consider a "hot tire" to be any tire with a carcass temperature that exceeds ambient temperature by 30 degrees Celsius [C; 54 degrees Fahrenheit (F)]). The emphasis on adjusting only cold-tire pressures is to ensure reliable results. Pressure and temperature of a hot tire can be measured for some safety or maintenance purposes, but there are no accurate ways to adjust pressure under these conditions using commonly available equipment.

Some tire manufacturers recommend specific maintenance procedures for hot tire conditions. The procedures call for comparing tire pressures on wheels of like gear types (nose gear or main gear) to verify that they are in the same range and at least equal to the specified operational loaded pressure. At ambient temperatures, tire pressures should not exceed the specified operational pressure by more than 5 percent. For a hot tire, however, the overpressure amount can exceed 5 percent significantly. Comparative pressures, not the individual pressures, are significant. The following actions typically are appropriate when evaluating hot tires:

- If comparison of pressures on the same gear shows wide variation above the specified operational loaded pressure, possible reasons are previously inaccurate pressure adjustments or brake malfunctions;

- If tire pressure below the specified operational loaded pressure is measured, further evaluation of the problem should wait until cold tire pressures can be checked and leak tests can be performed; and,
- When tire temperatures appear to be excessively high compared to normal experience, measurement of the temperature is appropriate to evaluate tire condition. One manufacturer, for example, recommended that tires be removed from service if the tire-surface temperature exceeds 225 degrees F (107 degrees C) or if brake heat creates temperatures that exceed 300 degrees F (149 degrees C) at points where the tire is in contact with the wheel surface.[4] Otherwise, pressure checks should be conducted only after the tire/wheel assembly has cooled to ambient temperatures.

By recording ambient temperature with the cold tire pressure, maintenance technicians can make accurate comparisons over time, more easily identifying tire anomalies related to temperature and pressure loss, and avoiding conditions that lead to tire failures.

Maintenance technicians also should follow aircraft-maintenance-manual procedures for adjusting tire pressures based on changes in ambient temperature. The Rubber Manufacturers Association (RMA) of Washington, D.C., U.S. for example, recommends that when a difference in ambient temperature greater than 50 degrees F (28 degrees C) causes a lower tire pressure than the specified operating pressure, the cold-tire pressure should be adjusted to the specified operating pressure.[5] The relationship between pressure and temperature is that a temperature change of 5 degrees F (3 degrees C) is equivalent to a change in tire pressure of approximately 1 percent.

Concerning ambient-temperature change, tire manufacturers also generally recommend that before taking off for an airport where ground temperatures are significantly lower compared to the airport of departure, tire pressure should be adjusted so tires will be inflated to the specified operating pressure at the colder airport.[6] If the specified operating pressure is 220 psi (15 bars), for example, a temperature drop of 50 degrees F at the destination would require increasing tire pressure before departure by approximately 10 percent to 242 psi (16.5 bars). This adjustment — superseding the normal tire overinflation limit of 5 percent at constant ambient temperature — is necessary because the operating-inflation pressure remains constant to support the load of a specified aircraft configuration. Without this adjustment, a tire/wheel assembly would be significantly underinflated on arrival at the destination.

Successful tire-pressure maintenance requires not only adherence to 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 conditions or failure of the other tire/wheel assembly on that axle. Disposition of tire/wheel assembly components based on such inspections also should be explicit and compliance should be documented.

Because load ratings, ply ratings, physical dimensions and pressure specifications for aircraft tires are elements of safe operation, an essential step in all tire-pressure maintenance is to identify each tire correctly and to remove from service any tire for which standard identification marks are missing or unreadable.

Specified operating pressures for aircraft tires are measured in pounds per square inch (psi) or bars (one bar equals one million dynes per square centimeter; a dyne is the force required to accelerate a free mass of one gram by one centimeter per second per second). One bar is approximately 14.7 psi. Typical operating pressures range from approximately 150 psi to 230 psi (10 bars to 16 bars), with some pressures reaching nearly 300 psi (20 bars). A typical transport-category aircraft tire may be rated for a static load of 13,000 pounds (5,897 kilograms) and a maximum operating speed of 239 knots (443 kilometers per hour). Engineering standards require a new aircraft tire to withstand at least four times the rated inflation pressure for three seconds, and a recapped tire (retread) to withstand at least three times the rated inflation pressure for three seconds.

RMA has published the following operating-inflation-pressure maintenance criteria for aircraft tires. These 1994 criteria represent a consensus of tire manufacturers and provide an overview of safe tire-inflation practices:

- Pressure never should be released from a hot tire for adjustment to the recommended service pressure;
- Tire pressure should be checked at least once every 24 hours, at the start of operations, and/or after operation (hot tires should cool for at least two hours before the check [some tire manufacturers recommend three hours]);
- Mounted tires should be inflated with dry nitrogen where available from 100 percent to 105 percent of the minimum loaded service pressure. Minimum loaded service pressure is the inflation

pressure necessary to support the maximum operational load for that wheel position; and,

- Reinflate any tire found between 100 percent and 95 percent of minimum loaded service pressure to the correct pressure. Reinflate any tire found between 95 percent and 90 percent of minimum loaded service pressure to the correct pressure, and record this pressure adjustment in the maintenance log book to monitor leak rates.

Aircraft, wheel and tire manufacturers also stress the importance of maintaining equal pressure in dual tire/wheel assemblies. When pressures are unequal, the wheel with the higher pressure will bear a proportionally greater part of the total load, possibly exceeding the load for which the tire was designed. The goal is to discover any reduction of pressure — often invisible when one tire has correct pressure — before both tires fail. Logbook entries for pressure differences greater than 5 psi should be kept at each pressure adjustment so that any trend can be identified, and appropriate preventive or corrective actions can be taken.

Caution in Tire-pressure Adjustment Helps Prevent Injuries

Procedures followed by airlines and repair stations for inflating, deflating and adjusting pressure in aircraft tires vary. Nevertheless, common safety practices are being re-emphasized by aircraft and wheel-component manufacturers because of five incidents involving deaths or life-threatening injuries in recent years among maintenance technicians servicing tire/wheel assemblies.

Records of the U.S. National Transportation Board (NTSB) provide the following example of such an accident in 1992 at Dayton, Ohio, U.S. involving a McDonnell Douglas DC-9-32: "The left nose-wheel tire was damaged during pushback when the tow bar failed. The tire was replaced and while being serviced on the airplane, the tire rim failed, fatally injuring the mechanic. Examination of the bottle used to service the tire showed two pressure scales, bars on the outside and psi on the inside. One bar equals 14.7 psi. The high end of the scale was 10,000 psi [680 bars] and the bottle was pressurized to 4,000 psi [272 bars]. The tire was to be serviced to 150 psi [10 bars]. Examination of the fracture surface found, 'No … manufacturing or material defects fracture surface is consistent with a tensile-load type of failure.' According to the company, no low-pressure regulators were available. They are kept under lock and key when not in use, and the responsible person had already gone home for the day."

NTSB said that the cause of this accident was, "A failed wheel rim following an inadvertent overinflation by the mechanic. Additional causes were the failure of the mechanic to be aware of the pressure being used, and his failure to follow procedures. A factor related to the accident was the failure of the company to make available low-pressure regulators for their mechanics during normal work hours."[7]

Training and procedures for maintenance technicians have stressed the necessity of using appropriate pressure regulators, even if a wheel has an overinflation pressure-relief (OPR) valve. Aircraft maintenance manuals and component-assembly manuals also have included explicit warnings about the extreme risk of attaching a high-pressure nitrogen bottle directly to a tire/wheel assembly because the pressure can exceed the design limits for the wheel and the wheel tie bolts.

RMA further recommends that when inflating a tire/wheel assembly, the nitrogen-supply line should be regulated to a pressure no more than 50 percent higher than the tire-service pressure. The pressure of nitrogen gas in high-pressure bottles typically used to service aircraft is 3,000 psi to 4,000 psi (204 bars to 272 bars) — possibly 10 times to 25 times the required tire-service pressure. Aircraft manufacturers and operators have acknowledged that use of safety cages outside of tire shops is impractical for routine servicing of tire/wheel assemblies already installed on an airplane. Given the limited protection and the possibility of human error, proper tire-servicing procedures must be followed with maximum care.

The safest practice in demounting tire/wheel assemblies is to deflate tires before wheels are removed from the aircraft. Caution also is essential while unscrewing valve cores for deflation; tire pressure can eject the valve core with bullet-like speed and force.

RMA said that other tire bursts have occurred because of operating conditions such as overheating due to excessive taxiing or operating with a tire underinflated or overloaded; and excessive wheel heating due to high-energy braking, or a dragging brake. Incident reports from several sources show that malfunctioning wheel bearings also may cause overheating and tire failure. A tire/wheel assembly that has been damaged in service should be deflated by a remote means or — at a minimum — allowed to cool for at least three hours before the tire is deflated, said RMA.

Nitrogen Reduces Risk of Fire

Since 1987 in the United States, dry nitrogen gas has been mandatory for inflation of aircraft tires mounted on braked wheels of specific transport-category aircraft. The use of nitrogen (an equivalent inert gas may be approved) is intended to eliminate the possibility that a chemical reaction (oxidation) between atmospheric oxygen and volatile gases from the tire inner liner will cause an explosion of tire/wheel assemblies. Major tire manufacturers recommend that nitrogen be used at all times for all tires for maximum safety and for reduced degradation of casing plies caused by oxidation.

Airworthiness Directive (AD) 87-08-09 of the U.S. Federal Aviation Administration (FAA) specifies that aircraft tires mounted on braked wheels may not contain more than 5 percent oxygen by volume. The affected aircraft also must have a placard for maintenance technicians that says "Inflate tires with nitrogen only." The AD explains various means of compliance under an FAA-approved maintenance program and permits the substitution of air at remote locations that do not have nitrogen, provided that the oxygen content does not exceed 5 percent by volume, or within the next 15 hours of time in service, the tire is purged of air and inflated with dry nitrogen so that the oxygen does not exceed 5 percent by volume.

Before using compressed air to inflate a low-pressure tire in a location where nitrogen is not readily available, aircraft maintenance manuals should be consulted for exact procedures and tables required to calculate and limit the oxygen content of a tire/wheel assembly.

Several Factors Affect Accuracy in Tire-pressure Measurement

As a guide to safety decisions and maintenance procedures, aircraft-tire pressure must be measured with a reasonable degree of repeatable accuracy. Appropriate gauges — whether equipped with a highly legible analog-dial pointer (with at least 5 psi increments) or a digital display — require regularly scheduled calibration and consistent procedures.

Differences in inflation-gas pressures of the same tire often can be attributed to the differences in gauges. Tire specialists discourage the practice of keeping inaccurate gauges in service by adding a tag with notes about a known discrepancy; gauges that are not within specified tolerances should be repaired or replaced. Attempts to repair gauges with unapproved lubricants, tools or techniques also may reduce the gauge's accuracy to an unacceptable degree. For some critical measurements, such as pressure change in a new tire/wheel assembly over a 12-hour period or 24-hour period, the same gauge should be used for each measurement if possible.

Underinflation Produces Rapid Excessive Heat

Tire/wheel assemblies operated at significantly less than the specified pressure may experience any of the following problems:

- Tires may creep or slip on the wheels during landing or when brakes are applied, possibly leading to shearing of a valve and destruction of the entire assembly;
- Rapid or uneven wear may occur at or near the tread shoulder or the edge of the tire's tread (providing evidence of chronic underinflation);
- Tire sidewalls or shoulders may be damaged or crushed by wheel-rim flanges on landing or while taxiing the aircraft;
- Tires may flex over the wheel flange, with greater possibility of damage to the bead and lower sidewall areas, resulting in a bruise break or rupture of the cord body; and,
- Excessive deflection can cause ply cords in the tire body to loosen resulting in extreme heat, ply separation and destruction of the tire/wheel assembly.

Overinflation Increases Susceptibility to Damage

Aircraft tires should not be operated at pressures higher than the rated inflation pressure. Although engineering specifications require aircraft tires to withstand several times their rated pressure for a few seconds under test conditions, excessive inflation pressure may cause the aircraft tire/wheel assembly to explode with lethal force and fragments.

Aviation authorities also discourage the practice of compensating for excessive tire deflection on aircraft loaded near maximum takeoff weight by increasing tire pressure. More than 5 percent overinflation may cause the following effects:

- Excessive strain on the cord body of the tire;
- Excessive stress on the wheels;
- Accelerated center-tread wear;
- Reduced tire traction; and,
- Significantly increased tire/wheel-assembly susceptibility to cutting by foreign objects, bruises and impact breaks.

Interpretation of Pressure Changes Assures Safe Tire Condition

Aircraft maintenance manuals guide maintenance technicians in tire-servicing and tire-disposition decisions under a wide range of normal operations and unusual conditions. Tire-inflation procedures ensure regulatory compliance, safety and full service life in the use of new tires and remanufactured tires. The following procedures are suggested:

- An aircraft tire that was in service with pressure below 90 percent of the minimum loaded service pressure — or has lost more than 10 percent of pressure between scheduled daily pressure checks — should be demounted and returned for examination by the manufacturer or by an authorized retreader to determine whether the tire is acceptable for continued use; and,
- Any tire/wheel assembly that was in service with pressure below 80 percent of minimum loaded service pressure similarly should be removed from service along with its axle mate, except when the pressure loss is known to have occurred while the aircraft was parked and not moved.

Wheel Components Help Protect Tires From Overpressure

In the tubeless-tire design used most commonly for transport-category aircraft, the tire and wheel both are part of one assembly that retains gas pressure by sealing the tire bead against the wheel bead seat. Aluminum or magnesium wheels for these aircraft typically are assembled from split rims or one rim with a demountable flange. Mated surfaces of the wheel are sealed against pressure loss by an O-ring. The inflation gas is added or removed through a tubeless-tire inflation valve mounted in the wheel. Tires, whether of conventional bias-ply design or more recent radial design, are a composite material of rubber, fabric and steel components.

Depending on their use, some aircraft wheels have fusible plugs (fuse plugs) and/or OPR valves. Fuse plugs have a metal core that melts at a specific temperature to release gas pressure before a tire/wheel assembly has an explosive failure. Such plugs mainly provide protection against explosive failure caused by excessive heat generation from brakes. Tires should be scrapped if extreme temperatures cause the fuse plug to release the inflation gas, because such temperatures may cause reversion of rubber (that is, change to the weaker uncured state) in the rim-contact area, but defective fuse plugs and leaks around fuse plugs also should be considered.[8]

The various valves, valve caps and seals on a tire/wheel assembly can be checked for leaks by wetting the component with a leak-detection solution, or by immersing the tire/wheel assembly in water. Repairs often can be made and parts replaced without demounting the tire from the wheel.

Another component — tire sidewall vents — also has a safety function and should be checked carefully. Sidewall vents prevent pressure buildup within the tire carcass body. Such pressure can cause tread, sidewall or ply separation. Therefore, the vents provide a path to bleed off a small amount of nitrogen — enough to produce bubbles in leak-detection solution but not enough to be felt by hand — trapped in the cord body. The industry standard for maximum allowable diffusion after an initial 12-hour stabilization period is 5 percent pressure loss in any 24-hour period. Tire inspections should include sidewall vents, which occasionally are sealed inadvertently by spilled solvent, tire paint or retreading.

Checklists Identify Sources of Pressure Loss

The cord body of a typical new aircraft tire has an initial 24-hour stretch period during which a normal pressure drop of 5 percent to 10 percent may occur because the volume of the tire will increase. A new tire should not be placed in service until at least 12 hours after being mounted and inflated to the specified operating pressure. Tire manufacturers also recommend pressure checks more frequently than normal for a few days after this stabilization period.

The minimum service pressure for safe aircraft operation is the cold unloaded inflation pressure specified by the airframe manufacturer. A tolerance of minus zero percent to plus 5 percent of this minimum pressure is the recommended operating range. If pressure of a tire installed on an operating aircraft is checked with an accurate gauge and found to be less than the minimum pressure, the specific schedule of pressure interpretation and actions adopted by the operator should be followed carefully. Some operators require a visual tire inspection — including checks with a gauge — after every landing or at every turnaround.

Visual examination of aircraft-tire deflection is unreliable for detecting small, but significant, losses of tire pressure. Thus, even the slowest nitrogen leaks in an aircraft tire/wheel assembly can lead to an unsafe loss of pressure within two days to three days, causing damage if not detected and repaired promptly. If pressure drops of 5 percent to 10 percent are not detected, and tires operate for long periods in this condition, inadequate inflation weakens the tires even though there appears to be no damage. Internal structural damage to tires after use of greater-than-normal braking energy also may be invisible. Thus, checklists should incorporate all the airframe manufacturer's procedures and guidelines for determining air-worthiness in these conditions.

Typical inspection checklists include items such as:

- Cuts or punctures;
- Evidence of damage from excessive heat;
- Leaking valve cores, valve-hole seals, valve caps, fuse plugs or OPRs;
- Damage to O-ring seals and other sealing surfaces, or improper O-ring installation;
- Holes or cracks in wheel assemblies;
- Improperly torqued wheel tie bolts;
- Damage to tire beads (cracks or scratches);
- Poor seating or improper seating in the bead area;
- Damage to the tire inner liner (or tube);
- Ambient temperature change; and,
- Status of the initial stretch and stabilization period for new tires.

Identifying these underlying causes of tire-pressure anomalies helps assure safe operation of aircraft. The complete maintenance process — including routine pressure checks of tire/wheel assemblies — increases the probability of timely problem detection, prevention of serious damage and reaching the expected tire service life.

Notes and References

1. Deflection is a percentage based on a series of calculations using simple measurements of tires and wheels when a tire is not installed on an airplane (unloaded) and when a tire is installed on an airplane (loaded). First, free height is calculated by subtracting flange diameter from outside diameter and dividing the difference by two. (Flange diameter is measured at the top of the wheel rim flange; outside diameter is measured at the circumferential center line of an inflated tire.) Then, loaded free height is calculated by subtracting one-half the flange diameter from the static loaded radius. (Static loaded radius is the distance from the center of the axle to the runway for a loaded tire.) Finally, deflection is

calculated by subtracting loaded free height from free height and dividing the difference by free height.

2. The U.S. Federal Aviation Administration (FAA), the Rubber Manufacturers Association, Michelin Aircraft Tire Division, the Aviation Products Division of the Goodyear Tire & Rubber Co. and the Aircraft Tire Sales Department of Bridgestone Corp. said that loaded inflation pressure is 1.04 times unloaded inflation pressure because of tire deflection.

3. 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 and the U.S. National Transportation Safety Board, 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 tire pressure less than recommended values.

4. Bridgestone Corp. *Bridgestone Aircraft Tires: Tire Specification & Maintenance Manual*. Tokyo, Japan. November 1997.

5. Tire Division, Rubber Manufacturers Association. "Aircraft Tire Recommended Operating Inflation Pressure Maintenance Criteria." March 8, 1994. "Aircraft Tire Bursts." October 1989. *Aircraft Tire Information Service Bulletin*. Washington, D.C., U.S.

6. For example, the Aviation Products Division of the Goodyear Tire & Rubber Co. recommends adjustment for an expected temperature drop that exceeds 50 degrees Fahrenheit (F) and the Aircraft Tires Sales Department of Bridgestone Corp. recommends adjustment for an expected temperature drop greater than or equal to 25 degrees Celsius (77 degrees F).

7. Prepared from the official records of the NTSB Aircraft Accident/Incident Database by Air Data Research, 13438 Bandera Road, Suite 106, Helotes, Texas 78023, U.S.

8. U.S. Federal Aviation Administration. "Chapter 9: Landing Gear Systems." *Airframe and Powerplant Mechanics Airframe Handbook*. Advisory Circular AC65-15A. 1976.♦

Cracked Case Causes JT9D Engine Failure On Takeoff

The U.K. Air Accidents Investigation Branch (AAIB) cited a Boeing 747-136 in-flight engine shutdown in recommending action to prevent cracking of the combustion-chamber outer case (CCOC) in Pratt & Whitney JT9D turbofan engines.

The B-747 was on takeoff May 27, 1997, from London (England) Heathrow Airport when the flight crew saw a caution light indicating that the no. 2 engine exhaust-gas temperature was greater than 915 degrees Celsius (1,679 degrees Fahrenheit).

The AAIB, in its incident report, said, "The flight engineer immediately reduced the thrust lever setting, almost simultaneously noted that other no. 2 engine parameters had suffered a major decrease, and informed the other crewmembers that the engine had failed." The crew shut down the engine, flew the airplane to 10,000 feet and jettisoned fuel over the English Channel to reduce airplane weight to maximum allowable landing weight. The crew then landed the airplane at Heathrow.

The report said that the no. 2 engine CCOC had a 69-inch (175-centimeter) crack that leaked high-temperature gas and damaged rotating engine components.

The report said the CCOC was "an early-version fabricated case with a welded axial seam and welded boroscope and drain bosses." (The later version is a one-piece case.) The report said that since 1991, three other incidents involving extensive fracturing of JT9D fabricated CCOCs have been reported.

Based on these findings, the report recommended that the U.K. Civil Aviation Authority and the U.S. Federal Aviation Administration "review the history and engineering analysis of the fabricated type of [CCOC] used on the JT9D engine and mandate measures aimed at preventing recurrence of instances of extensive cracking of the case."

FAA: Chafed Fuel-float-switch Wiring Could Cause Explosion

The U.S. Federal Aviation Administration (FAA) has ordered operators of Boeing 737s to inspect and, if necessary, to replace center-fuel-tank float switches and wiring, and to install Teflon sleeves over the float switches and wiring.

The maintenance procedures are in Airworthiness Directive (AD) 99-05-12, which was prompted by a report of chafed wiring in eight B-737s. FAA said that the airplanes had between 32,000 flight hours and 85,000 flight hours, and that the chafing was caused by vibrational contact between the wiring and wiring conduits.

"The actions specified in this AD are intended to detect and correct such chafing and the resultant arcing from the wiring to the in-tank conduit, which could present an ignition source inside the fuel tank and consequent fire/explosion," said FAA.

The AD is applicable to 100, 200, 300, 400 and 500 series B-737s, and requires compliance with Boeing Alert Service Bulletin 737-28A1132, issued on Dec. 2, 1998, and revised on Jan. 15, 1999.

NTSB Urges Inspection of MD-11 Cockpit Wiring

Evidence of electrical arcing in a McDonnell Douglas MD-11 that was involved in an accident near Peggy's Cove, Nova Scotia, Canada, on Sept. 2, 1998, has prompted the U.S. National Transportation Safety Board (NTSB) to recommend inspection of MD-11 cockpit wiring.

NTSB is participating in the Transportation Safety Board of Canada (TSB) investigation of the accident, which occurred after the crew of the MD-11, Swissair Flight 111, reported smoke in the cockpit and requested clearance to divert the flight to a "convenient" airport. Air traffic control (ATC) cleared the crew to fly directly to Halifax International Airport in Nova Scotia. The crew declared an emergency; communication between ATC and the crew ceased shortly thereafter. The airplane then struck the water. All 229 occupants were killed.

NTSB said, "Numerous sections of wiring from the cockpit overhead area … exhibited heat damage and burned insulation, and several of the wires from those sections showed evidence consistent with electrical arcing. Although some of the wires exhibiting arcing characteristics are from the entertainment system that is unique to the Swissair MD-11 fleet, others have been identified as original MD-11 wires."

NTSB said that, as of January 1999, the accident investigation has not determined that the electrical arcing caused a fire. Nevertheless, NTSB recommended that the U.S. Federal Aviation Administration require inspection of wiring in and around MD-11 cockpit overhead circuit-breaker panels and avionics circuit-breaker panels.

When Red Tape Is Good For Your Aircraft

While participating in a safety audit of a large corporate-aircraft operator, the maintenance auditor found a situation that could have led to a serious flight-instrument abnormality. The discovery came as the auditor observed two maintenance technicians troubleshooting a Sikorsky S-76 helicopter air-data-system problem. The technicians were conducting a leak test of the pitot-static system.

The helicopter's paint scheme featured a one-inch (2.54-centimeter) black stripe along the tail boom. On closer observation, the auditor saw that the alternate static port, installed flush in the tail-boom skin within the black stripe, had been covered with black tape to seal the static system for the leak test.

The maintenance technicians had made an entry in the aircraft flight logbook that the pitot-static system was being tested. Nevertheless, the possibility existed that the black tape might be overlooked by the technicians after the test was completed, or overlooked by pilots during a walk-around preflight inspection of the helicopter.

The auditor asked the technicians why they did not use red tape, rather than black tape, to cover the alternate static port. The auditor said that red tape (or another conspicuously different color) would be a conspicuous reminder that its removal was required after the test. The maintenance technicians said that they had not thought about using red tape, but agreed that it was a good idea.

The auditor then recommended that the aviation-department manager purchase a few rolls of red tape and store them with the pitot-static test equipment for future use.♦

NEWS & TIPS

Static-grounding Cable Reels Designed for Hazardous Areas

The Hannay Reels HGR series spring-rewind reels for grounding cables are designed for use in explosive atmospheres and hazardous conditions including aircraft fueling, rescue operations, and other situations where static electricity could cause a spark and an explosion, said the manufacturer.

The reels are offered in four different models and provide for the payout, retraction and storage of from 20 feet to 100 feet (6.1 meters to 30.5 meters) of static grounding cable. The reels feature spring rewind motors, lock in any position in a 270-degree arc and require minimum cable pull to release the lock.

For more information: Hannay Reels, 553 State Route 143, P.O. Box 159, Westerlo, NY U.S. 12193-0159. Telephone +1 (518) 797-3791.

Torque Tester Stores Readings

ASG's new HDM-100 digital torque tester can store torque data for up to 450 screws or bolts. The device measures the torque of fasteners and gives both audible and light signals when torque reaches a user-selected tolerance range of plus or minus 3 percent, 5 percent or 10 percent. Readings may be displayed in Newtons per meter, kilograms force per meter or pounds force per inch.

ASG HDM-100
Digital Torque Tester

The tester can measure in both clockwise and counterclockwise rotation, and the torque of already tightened fasteners can be measured in first-peak mode to an accuracy of plus or minus 0.5 percent. The device has automatic zero adjustment, and printer and analog output jacks.

For more information: ASG Division of Jergens, 19520 Nottingham Road, Cleveland, OH 44110 U.S. Telephone +1 (210) 486-6163.

Portable Video Microscope Is Self-contained

The Olympus PV10 video microscope can be hand held and operated anywhere, said the manufacturer. The device allows video inspection of components that cannot be viewed with conventional microscopes, and it features a variety of zoom and single-focus lenses for maximum depth of field, longer working distances and magnification up to 1000X.

The PV10 accommodates lighting attachments and is compatible with Olympus borescopes and fiberscopes for inspecting hard-to-reach places.

For more information: Olympus America, Industrial Products Group, Two Corporate Center Drive, Melville, NY 11747 U.S. Telephone (800) 446-5260 (U.S.); +1 (516) 844-5888.

Cabinets Provide Static-safe Storage

Electronic equipment sensitive to electrostatic discharge (ESD) can be stored safely in the StaticGard Sentry 100® modular drawer cabinets and work stations, said the manufacturer. The equipment meets test criteria of the ESD Association and the American National Standards Institute (ANSI) Accredited Test Standards and Advisories.

Sentry 100 products are shipped in static-neutral packing materials and covered with static-safe packaging. Drawer labels and interior partitions and dividers are also treated to control static.

For more information: Stanley Storage Systems, 11 Grammes Road, P.O. Box 1151, Allentown, PA 18105-1151 U.S. Telephone: (800) 523-9462 (U.S.); +1 (610) 797-6600.

Pneumatic Tool Aids Ring Installation

The Simonds SR-100 Pneumatic Snap Ring tool operates from shop air at a pressure of 80 pounds per square inch (5.6 kilograms [kg] per square centimeter) and eliminates the need for repetitive manual squeezing, said the manufacturer. The ergonomic hand tool installs internal snap rings from one-half inch to 1-3/8 inches (1.27 centimeters [cm] to 3.49 cm) without repetitive manual squeezing.

Simonds SR-100
Pneumatic Snap Ring Tool

The tool features interchangeable 0.094-inch (2.4 mm)-diameter tips for straight, 45-degree and 90-degree approaches. When the trigger is activated, the jaws close evenly with 780 pounds (354 kg) of force.

For more information: Simonds, 248 Elm St., P.O. Box 100, Southbridge, MA 01550-9921 U.S. Telephone: +1 (508) 764-3235.

Portable Space Cooler Provides Hot-weather Comfort

The Advanced Radiant Systems COOLSPACE Portable Evaporative Cooler reduces effective air temperature as much as 26 degrees Fahrenheit (14 degrees Celsius) at low operating cost in outdoor or semi-enclosed spaces and in high relative humidity, said the manufacturer. (Effective temperature is a measure of the physiological impact of air temperature, relative humidity and air speed.) The unit operates on 115-volt power and uses water from a standard hose or optional portable tank.

The cooler uses an 18-inch (0.45-meter) single-speed fan to move air through moist cooling pads (replaceable at four-year to five-year intervals). The unit weighs 75 pounds (34 kilograms [kg]) without water and approximately 100 pounds (45 kg) with water. The housing of the cooler is polyethylene, and electrical terminals and connections are watertight.

Advanced Radiant Systems COOLSPACE Portable Evaporative Cooler

For more information: Advanced Radiant Systems, 12910 Ford Drive, Fishers, IN 46038 U.S. Telephone (800) 557-5716 (U.S.); +1 (317) 577-0417.

Wrenches Designed to Reduce Hand Injuries, Fastener Damage

Knuckle Saver wrenches incorporate design features that prevent wrench slipping and reduce damage to fasteners, said the manufacturer. Mac Tools has incorporated a locking groove to help keep the wrench from slipping from the fastener, and an arched inner surface to improve contact between wrench and fastener. Increasing the contact area allows more force to be applied without rounding the fastener.

To reduce slippage of the wrench, a slight step in the jaw face inter locks the wrench with the fastener and reduces the probability that the wrench will slide off the fastener when force is applied, said the manufacturer.

For more information: Mac Tools, 4635 Hilton Corporate Drive, Columbus, OH 43232 U.S. Telephone: (800) 622-8665 (U.S.); +1 (614) 661-5300.

New Grommet Receives FAA Approval

Device Technologies, a manufacturer of composite grommet edging, has received U.S. Federal Aviation Administration endorsement for Spring-Fast® Grommet Edging. The product has a chafe-resistant surface that prevents fraying of wires in new or aging aircraft, said the manufacturer.

The edging is a composite made of polymer-encapsulated stainless steel with a sacrificial cushion that provides a smooth, nonconductive surface to protect wire and cable from abrasion, according to the manufacturer. The stainless steel core snaps on and locks into place without adhesives. Eight sizes are available, from 0.025 inch to 0.25 inch (0.64 millimeter [mm] to 6.4 mm).

For more information: Device Technologies, 3 Brigham Street, Marlborough, MA 01752 U.S. Telephone: (800) 669-9682 (U.S.); +1 (508) 229-2000 .

Data Display Documents Servicing of Large, Vented NiCd Batteries

The Christie Electric Corp. ProEase DataFX™ data display unit works with charger-analyzers to document servicing of batteries typically used in aircraft applications. Improvements include all-new circuitry and software; a larger display that shows up to 22 cell voltages, amperage, total voltage and fault messages simultaneously; and a print function to document displayed data, said the manufacturer.

The new DataFX is available now, and retrofit options are available to owners of the original model.

For more information: Christie Electric, 18120 South Broadway, Gardena, CA 90428 U.S. Telephone: +1 (310) 715-1402.♦

Christie Electric Corp. ProEase DataFX™

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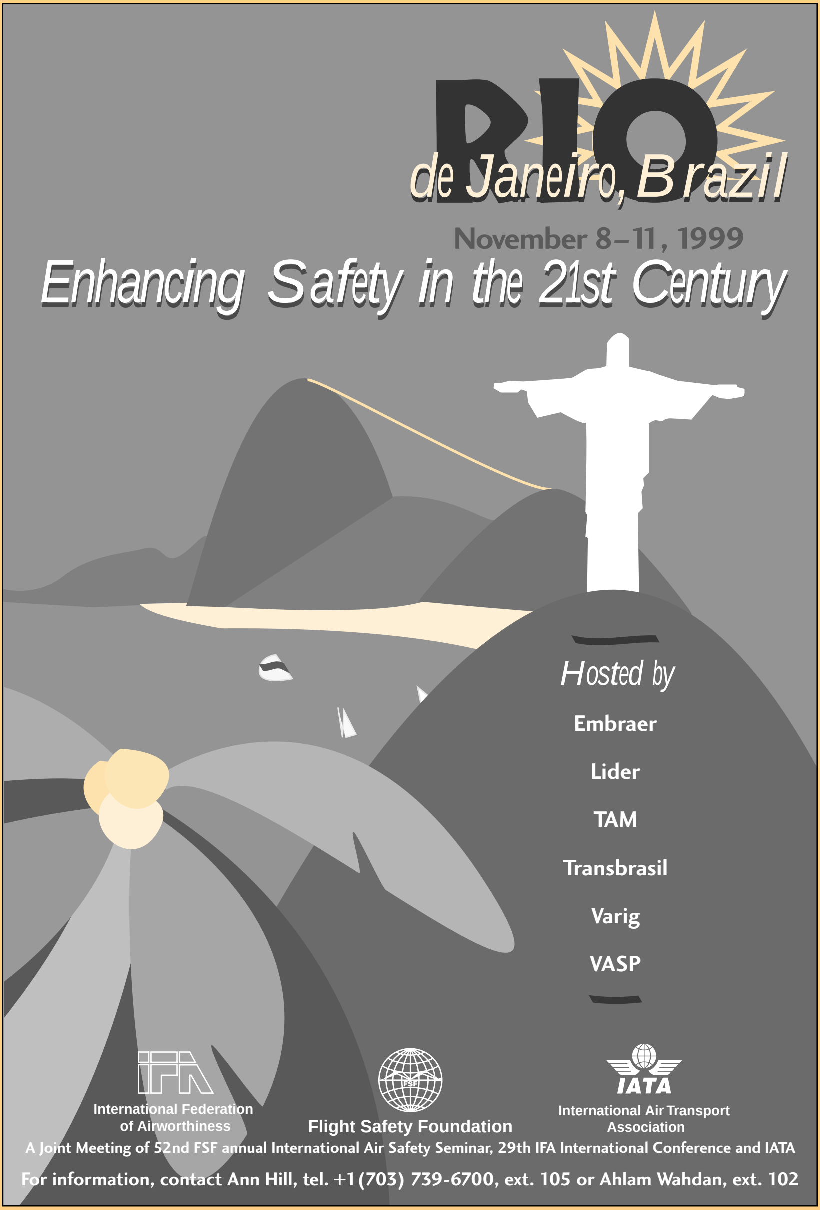
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