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# Improper Inflation Cited in Six Tire-failure Incidents

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Robert A. Feeler, editorial coordinator

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# Improper Inflation Cited in Six Tire-failure Incidents

***The U.K. Air Accidents Investigation Branch said that more frequent monitoring of tire pressure would increase chances of identifying a seriously underinflated tire before a tire failure occurred.***

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*FSF Editorial Staff*

The U.K. Air Accidents Investigation Branch (AAIB), citing six incidents of tire failures on Empresa Brasileira de Aeronáutica (Embraer) EMB-145 airplanes, is recommending an increase in the frequency of visual inspections of tires on EMB-145s and research into possible causes of leaking from the tires' wheel fuse plugs.

AAIB said, in the final report on the last of the six incidents, which occurred in Birmingham, England, that an examination of the wheel assembly revealed "that the most likely cause of the tire failure was … overstress in the tire carcass, which may have been a result of the tire running underinflated."

The problem "could have been identified by in-service monitoring and recording of tire pressures," the report said.

The report said that the six incidents did not all involve the same operator or the same tire manufacturer.

The Birmingham incident occurred at 2025 local time Nov. 18, 2003, during takeoff for Düsseldorf, Germany. The airplane received minor damage; none of the 47 people in the airplane was injured.

"The takeoff was normal, except for the requirement of a more positive rate of rotation than normal," the report said. "Following this, and as the aircraft accelerated, the commander [captain] felt a vibration through the control column. At the same time, a passenger noted that as the [landing] gear retracted, the wings waggled slightly to the right, followed by a loud banging noise from the bottom of the aircraft, which worsened as the aircraft's airspeed increased. He had also noted that during the taxi from the stand [gate] at Birmingham, there was a 'roughness' felt through the aircraft that had continued until takeoff."

The cabin crew told the captain about the noise, and the captain — despite normal system indications on the flight deck — slowed the airplane to 210 knots, leveled the airplane at Flight Level 90 (approximately 9,000 feet) and requested a return to Birmingham Airport. He declared pan-pan, an urgent condition, and prepared for an emergency landing. No damage was apparent when aircraft rescue and fire fighting personnel met the airplane on the runway after the landing, but after the airplane was taxied to the gate, ground personnel told the captain that the left-inboard main wheel tire (the no. 2 tire) had "shed its tread.

"The detached tire tread had flailed around as it departed the tire, and pieces of tread became trapped between the main [landing] gear and its side stay. The main [landing] gear also exhibited signs of contact from the tire tread as it shed. There was also damage to the flap because of the tread striking the trailing edge of the composite panel as it departed the tire. In addition to losing its tread, the … tire had deflated, and it had a large split in its sidewall."

The damaged tire and its companion tire — the left outboard main wheel and tire (the no. 1 tire) — were removed for further investigation.

## Fuse Plugs Relieve Excess Tire Pressure

The main-wheel assembly on EMB-145 airplanes is comprised of two halves of forged aluminum alloy, joined with tie bolts. The tubeless tires are held in place on the inner rims of each half of the main-wheel assembly. An inflation valve and an overinflation valve, which is used to relieve tire pressure when the tire pressure exceeds the allowable level, are located on the outer wheel half.

Around the center of the wheel assembly are three equally spaced thermal-relief plugs (fuse plugs) that are used to relieve tire pressure when the wheel reaches a specified temperature — typically after the heavy braking required in a high-energy stop. The fuse plugs consist of a "eutectic fuse material" — a metallic compound that resembles solder and that melts at a specified temperature. On the outer edge of each fuse plug is a groove for an o-ring to enable an airtight seal with the wheel assembly.

The report said that the fuse plugs are installed using a wooden dowel to prevent damage to the eutectic fuse material and are "push-fitted into their fitting on the pressure side of the wheel.

"The plug then sits on a recess, which contains a hole to allow the air from the tire to escape to atmosphere when the plug relieves. When the wheel temperature increases to a predetermined level, the eutectic melts, breaking its bond with the fuse body, and the air pressure from the tire pushes the eutectic out of the plug, leaving a hole for the release of tire pressure."

The report said that the main-wheel tires on the incident airplane were 16-ply-rated cross-ply tubeless tires with a speed rating of 182 knots.

"The tire casing is made of a series of plies of cord, coated with a rubber compound forming a 'fabric,' installed around metal beads with each layer laid at a different angle to obtain the bias, or cross-ply," the report said. "The beads hold the tire to the wheel rims and are made of high-tensile wire; above each bead runs a rubber apex piece. At the interface between the tread and tire casing are layers of nylon fabric known as the inter-tread fabric. The inner liner is an impervious rubber compound applied to the tire's inner face to prevent leakage of gas and moisture ingress into the casing. Awl vents in the tire sidewall allow excess air inside the casing to be vented to atmosphere."

## Tests Determine Acceptable Number of Retreads

Because tire treads typically wear out before the tire casings, retreads are applied to extend the tires' useful service life. The number of retreads per tire depends on the tire and type of operation in which the tire is used.

"The process of determining a retread level (the number of permitted retreads) is one of testing in-service tires for the level of degradation during a certain operation," the report said. "A sampling of tires that are beyond 80 percent worn are subjected to … nondestructive testing and then destructively tested to determine the current structural integrity of the tire. A judgment is then made as to whether the tire will survive an escalation in the retread level."

When a retread level is established, the decision is based on an assumption that the tire has been operated at the correct pressure and in accordance with the aircraft maintenance manual.

"This gives a high level of confidence that following a retread, the tire structure will outlast the tread wear," the report said. "A tire which has run underinflated or in an overloaded condition will reduce the fatigue life, leading to potential casing failure sooner than predicted."

The tires on the incident airplane were retread-level-3 tires.

## Recognized Typical Symptoms of Underinflated Tires

When a tire is sent to a company that performs retreading operations, the tire is first visually inspected and other checks are conducted on its serviceability and its history to help determine its condition. A tire that has been operated underinflated typically has creases in the inner liner or excess shoulder wear; these tires are scrapped because they have been subjected to excess stress.

If a tire is selected for retreading, visual inspections are conducted throughout the retreading process, followed by a type of nondestructive testing known as shearography, which involves a digital scan of the retread — and sometimes also of the sidewall — to identify areas of total adhesion failure in the plies beneath the tread. (Shearography does not identify weaknesses or impending fatigue failures of the casing plies, however.)

The incident airplane's no. 2 tire had been on the airplane for 115 flight hours and 108 landings.

"The tire's work records showed that the previous retreads were satisfactory, with no recorded anomalies," the report said. "Moreover, there was no evidence to suggest that the tire had run underinflated at a previous retread level."

The no. 2 wheel assembly had accumulated 3,039 flight hours and 2,721 landings, with five tire changes. The wheel assembly had been overhauled once, 476 flight hours and 391 landings before the incident. During the overhaul, the fuse plugs were "disturbed" and their o-ring seals were replaced, the report said.

The no. 1 wheel assembly had accumulated 6,929 flight hours and 6,423 landings since manufacture, with 15 tire changes. The fuse plugs and o-rings had been replaced once — during a September 2002 overhaul, 1,421 flight hours and 1,209 landings before the incident.

## Tread Separated From Incident Tire

Tire inspections conducted after the incident revealed the following:

> The no. 2 tire had a fully separated tread, which had occurred at the original interface with the tire carcass and not in the retread area. The recovered tread accounted for less than 15 percent of the tire, but measurements of this tread showed around 20 percent wear, with some scuffing and abrasion to the remains of the shoulder ribs. …
>
> Further examination of the tire, once removed from the wheel assembly, revealed large fractures to the inner liner. Two of these were localized fractures, but one fracture extended diagonally from an area immediately above the bead filler to the upper shoulder area. The inner liner, however, did not show signs of the tire running for prolonged periods at reduced pressure or [operating] with the tire deflated. Areas of wear on the exposed carcass were determined to be related to concave depression, either from landing or from braking, and were related to the tire being deflated — or nearly so — on landing.

Inspections also showed a "localized casing breakup within the plies." The tire manufacturer said that the casing breakup was a result of "over-deflection of the tire sidewall" — a problem typically associated with operations of an underinflated or overloaded tire.

The tire inspections also revealed that the companion no. 1 tire had "about 20 percent tread wear and showed heavy abrasion to the shoulder ribs of the tread. This was indicative of overloading and was considered a result of the deflation of the no. 2 tire, with the aircraft load transferring onto the no. 1 tire during landing."

Examinations of the wheel and tire assemblies revealed leaks from all three fuse plugs on the no. 2 tire and from one fuse plug on the companion no. 1 tire. The wheel manufacturer said after subsequent tests of the no. 1 tire that a pressure loss of more than 5 percent in 24 hours was "unlikely"; nevertheless, the report said that after 12 hours, the recorded tire pressure was less than 97.5 percent of the original tire pressure and that during this 12-hour period, another fuse plug was found to be leaking.

Similar tests found one leaking fuse plug on the companion wheel to a failed no. 2 wheel and tire assembly from an EMB-145 involved in one of the five similar incidents. That incident occurred during takeoff from

Venice, Italy, on Nov. 15, 2003. The report said that the tests showed that after 12 hours, tire pressure also was less than 97.5 percent of the original tire pressure[1] (see "AAIB Cites Similar Tire-failure Incidents," page 7).

The wheel-assembly component maintenance manual (CMM) says that at every tire change, the fuse plugs should be removed for inspection and reinstalled with new o-ring seals. After reassembly of the wheel assembly, a leak test is performed with the tire pressurized to its specified operating pressure, and three hours later, the pressure is measured. If the pressure is less than 95 percent of the original pressure, a leak investigation is conducted.

If the pressure is 95 percent or more, the tire is re-inflated and is stored for 12 hours.

"If, after 12 hours, the tire pressure is not less than 97.5 percent of the original pressure, the tire is accepted and released for aircraft service," the report said. "If the pressure is less than 97.5 percent, then a further 12-hour test is required. If the pressure then drops below 97.5 percent again, an inspection and repair of the wheel and tire is required."

## Eutectic Fuse Material Damaged

Examination of the leaking fuse plugs from the airplane involved in the Birmingham incident showed that their o-ring seals were in satisfactory condition but that in some of the fuse plugs, the leak was a result of damage to the eutectic fuse material. The wheel manufacturer said that the damage broke the bond between the material and the rest of the fuse plug; in some of the fuse plugs, the damage was identified as a melting of the material because of excess heat generated by the brakes after landing.

The report said that incident investigators' discussions with wheel repairers revealed that leaking fuse plugs typically were found in about 5 percent of wheels that were taken to repair shops for repairs or tire changes.

"This would indicate that there may be a pre-existing problem with the fuse plugs and that this problem may be related to a breakdown of the bond between the eutectic material and the fuse-plug body," the report said. "The problem may be caused by heat soaking during normal service, general wear and tear, or the operational usage pattern of the aircraft.

"When a wheel repairer finds a fuse plug leaking, the normal course of action is to replace the plug and o-ring seal and discard the defective plug without further investigation. This practice makes it difficult to detect if there is a problem with the plugs

*Continued on page 8*

## AAIB Cites Similar Tire-failure Incidents

In addition to the tire-failure incidents in Birmingham, England, and Venice, Italy, the U.K. Air Accidents Investigation Branch (AAIB) cited the following similar incidents involving Empresa Brasileira de Aeronáutica (Embraer) EMB-145 airplanes. (Operators and tire manufacturers were not identified.):

- On July 28, 2003, during takeoff from Frankfurt, Germany, on a flight to Skopje, Macedonia, the flight crew observed a cockpit indication of hot brakes and felt vibration and "continuous bumping." They rejected the takeoff at 80 knots and stopped the airplane on the runway. An investigation revealed that both left-main landing-gear tires had failed. The report said that the tire manufacturer "concluded that both tires had been severely overloaded, possibly as a result of one or both of the tires running underinflated."
- On June 5, 2003, during takeoff from Oslo, Norway, people in the airplane felt vibrations "similar to a rough runway surface." One passenger said that he observed debris on the right side of the airplane, and another said that the debris was ingested by the right engine. Aircraft system parameters were normal, but visual inspection of the right engine by a crewmember revealed "possible ingestion of a foreign object." The crew declared pan-pan, an urgent condition, and returned to Oslo; during the landing, the tire burst. The report said, "The likely cause, although not conclusive, was that the tire had been running underinflated." The tire was at retread level 4 (had been retreaded four times) — the only EMB-145 tire at this level. "The tire manufacturer immediately stopped all retread operations beyond retread level 3, but would carry out investigations into the retread-escalation program with a view to reintroducing retread level 4," the report said.
- On Nov. 16, 2001, during a night takeoff from Munich, Germany, the flight crew heard a bang and saw "flashes." They left the landing gear extended, and air traffic control confirmed that the flashes were sparks from the landing gear and that there was tire debris on the runway. They returned to Munich for an uneventful landing. An inspection revealed that both left-main landing-gear tires had burst, damaging the wheel and brake assemblies. The tire manufacturer said that the tires had been underinflated "for a long period of time, causing premature [tire-]carcass fatigue."
- On Aug. 4, 1997, as the flight crew rotated the airplane for takeoff from Bilbao, Spain, they felt a vibration in the cockpit. They left the landing gear extended, observed no abnormal indication in the cockpit and continued the flight to Oporto, Portugal. During approach, they declared an emergency and conducted a normal landing. They later found that both left-main landing-gear tires had shed their treads. Further inspection revealed excess shoulder wear and cracks in the grooves of the tread that remained on the tires. The report said, "This evidence led to the conclusion that the tires had been underinflated and that the no. 1 tire had failed on takeoff at Bilbao and the no. 2 tire had then failed on landing at Oporto." This event resulted in publication of Service Newsletter (SNL) 145-32-0002, in which Embraer "strongly recommend[ed] that tires be pressure-checked and serviced every 24 hours, at least three hours after the last landing of the day." The SNL said that, because tires are manufactured with a high percentage of porous natural rubber, daily air losses range from 1 percent to 5 percent.♦

and exposes the need for investigation by the wheel manufacturer into the underlying reasons for leaking fuse plugs."

As a result of the investigation, AAIB recommended that the manufacturer, Goodrich Aircraft Wheels and Brakes Division, should "carry out research into the possible causes of the fuse-plug leakage and consider action to reduce the risk of leaking fuse plugs."

The report said that the most recent tire-pressure entry in the technical log for the incident airplane was dated Nov. 7, 2003 — 11 days before the incident — and that tire-pressure loss could have been identified if the pressure had been measured and recorded more frequently. When the incident occurred, the operator checked tire pressures every 48 hours, during intermediate maintenance checks; an outdated version of the intermediate check, which did not require that tire pressures be recorded, had been inserted in the technical log.

The aircraft manufacturer recommends measuring tire pressure once every 24 hours, and the report said, "With a tire-pressure test every 24 hours, it is more likely that an underinflated tire will be identified before it causes a failure. However, if the tire-pressure trends were monitored, the increased frequency of pressure checks could be more effective, for if a tire requires re-inflating on several occasions, although the pressure is still within the 95 percent to 100 percent band, this could be an indication of a leak that, if ignored, has the potential to become worse. The logical action would be to remove the wheel assembly and investigate the cause of this 'slow' leak."

AAIB recommended that Embraer "amend the maintenance schedule for the EMB-145 and similar models to require that tire pressures are checked every 24 hours [and] the as-found [tire pressures] and re-inflation tire pressures are recorded in the technical log for monitoring purposes."

The report said that incident investigators had observed "a distinct lack of communication between the wheel repairers and the tire retreaders … with the reason for removal of a tire from an aircraft not being communicated to the tire retreader." Without such communication, the tire retreaders have no way of knowing whether a tire's fatigue life may have been compromised.

As a result of the investigation, AAIB recommended that wheel repair stations operating in accordance with European Joint Aviation Requirements or U.S. Federal Aviation Regulations be required to "inform the tire retreader of the reason for removal of the tire from the aircraft and indicate if there has been any suspicion of the tire running underinflated." The operator's wheel repairer accepted the recommendation, and also began replacing all fuse plugs and o-ring seals at each tire change, monitoring wheel assemblies for indications that fuse plugs are leaking and helping the wheel manufacturer in an investigation of the causes of the leaks.

The wheel manufacturer included in the CMM drawings for a fuse-plug test set to enable repair stations to provide information to the wheel manufacturer on possible causes of fuse-plug leaks.

After the incident, the operator began requiring daily tire pressure checks and introduced a specific form on which the pressure was to be recorded. In addition, the operator began replacing all tires that had been retreaded before introduction of the daily pressure checks and limited each tire to two retreads. After these actions were begun, several tires were found to have been underinflated and were removed from service, and five additional in-service tire failures were reported on the operator's aircraft; these events were being investigated.♦

[FSF editorial note: This article, except where specifically noted, is based on U.K. Air Accidents Investigation Branch report no. EW/C2003/11/03, 14 pages. The report is included in the September 2004 *AAIB Bulletin*.]

## Note

1. U.K. Air Accidents Investigation Branch (AAIB). Report no. EW/C2003/11/02. *AAIB Bulletin*, September 2004.

   This incident occurred during the takeoff roll, as the airplane neared rotation speed. The flight crew felt a "sudden but moderate vibration" but continued the flight to Manchester, England, because they were already committed to the takeoff and because all systems indications appeared normal. During approach to Manchester, the crew declared an emergency, but the landing was uneventful. The airplane received only minor tire damage, and none of the 43 people in the airplane was hurt.

   Tire debris was found on the runway in Venice, and an investigation revealed that the tread had failed because of overstress in the sidewall of the left-inboard main wheel tire (the no. 2 tire), which led to a break-up of the tire casing plies. The report said that the overstress was "attributed to the tire running underinflated due to an air leak from the overpressure valve. The leak was due to corrosion on the overpressure valve seat from a poor anodized layer during manufacture and a degraded o-ring seal."

   The report contained four safety recommendations: for Goodrich Aircraft Wheels and Brakes Division to require visual inspections of the inflation and overinflation valve seat areas at every tire change, to clarify a requirement in the Embraer EMB-145 wheel component maintenance manual (CMM) for replacement of o-ring seals at each tire change, to review the use of specific o-ring seals and to notify wheel repair stations of related changes in the CMM.

## Further Reading From FSF Publications


FSF Editorial Staff. "Managing Aircraft-tire Wear and Damage Requires Adherence to Removal Limits." *Aviation Mechanics Bulletin* Volume 47 (May–June 1999).

FSF Editorial Staff. "Monitoring Aircraft-tire Pressure Helps Prevent Hazardous Failures." *Aviation Mechanics Bulletin* Volume 47 (March–April 1999).

FSF Editorial Staff. "Tire Failure on Takeoff Sets Stage for Fatal Inflight Fire and Crash." *Accident Prevention* Volume 50 (September 1993).

Venter, Hennie. "How to Practice Good Tire Sense." *Aviation Mechanics Bulletin* Volume 18 (May–June 1990).


# MAINTENANCE ALERTS

## Test Flight Becomes Emergency After Maintenance Errors

During the climb after takeoff from Dublin (Ireland) Airport for a test flight following a "C" check on the Boeing 747-200, the flight crew perceived unusual airframe vibration. The wind shear alarm activated, and indicated airspeed was significantly lower than expected. The crewmembers then determined that the airspeed indicators and altitude indicators on both sides of the cockpit were under-reading (i.e., displaying lower-than-correct indicated airspeed and false altitude).

Flight conditions included poor weather and clouds. The captain declared an emergency. The crew was given radar vectors to return to the airport. Because of the inaccurate indicated airspeed, the landing was conducted at a higher than normal airspeed. There were no injuries to the eight flight crewmembers and technical personnel on board in the May 12, 2000, incident. (The report by the Irish Air Accident Investigation Unit [AAIU] was published June 2, 2004.)

The investigation found that the flap system had been damaged during the flight. The report said, "The seals at the fixed trailing-edge flap fairings at [the] no. 1 and [the] no. 8 position were blown out, and the trailing-edge boat fairings were also damaged. A crack was found in the left-hand outboard leading-edge flaps."

The damage was caused by inadvertent aircraft operation at an excessive airspeed with the flaps lowered, the report said, as a result of the inaccurate indicated airspeed.

"The airspeed indicators under-read due to pressurized air from inside the aircraft feeding into both pilots' static system through the static drains in the A&E [avionics and electrical] bay," said the report. "The sealing caps on these drains had not been refitted after maintenance. This fault also resulted in false altitude indications, false wind shear alerts, false vertical speed indications and false transponder altitude output."

The handover between work shifts on May 6, 2000, had resulted in the later work crew being unaware that the checking of the pitot-static system was not complete, the report said. The avionics crew manager recently had been transferred from line maintenance to overhaul maintenance.

"His appreciation, experience and comprehension of the need for the ongoing interaction of the various teams involved in overhaul maintenance may have been less than optimum," said the report.

In addition to the inadequate communication at the shift change, the report said, "A maintenance procedure was performed on this aircraft that was no longer approved by the aircraft operator for use on their version of the B-747. This superseded procedure permitted the use of the static drains for leak testing of the static system. The aircraft operator's approved method for performing leak tests, at the time of this maintenance, did not authorize use of the static drains for this purpose."

## Cable Misrigging Leads To Unscheduled Landing

As the Boeing 737-400 was rotated on takeoff from Canberra Airport, Australian Capital Territory, Australia, the pilot flying felt that the pitch control was "unusually stiff." After climbing to a safe altitude where aircraft controllability could be checked, the flight crew conducted a precautionary return to Canberra Airport. The aircraft was landed with no injuries or damage in the incident on Dec. 15, 2002.

At the operator's maintenance facility, it was determined that an elevator-control cable had been incorrectly located. "The control cable was hooked over the lip of a J-shaped floor-support beam, beneath the aft galley," said the report by the Australian Transport Safety Bureau.

A scheduled maintenance inspection had been completed on Dec. 13, 2002. During that inspection, the report said, "several flight-control cables had been disconnected to carry out a modification that required a removal of the flight-control columns. One of those cables was found, during the operator's subsequent investigation, to be hooked over the aft-galley floor-support beam. The scheduled maintenance inspection did not require the floor panels to be removed and therefore did not allow a complete inspection of the cables after the modification was completed."

Tests were conducted to determine how the cable might have become hooked over the J-shaped floor beam. “With normal operating tension on the cable, a force of approximately 30 kilograms [66 pounds] was required to place the cable over the beam,” said the report. “With only slight tension on the cable and the cable clamped, it could be readily placed over the beam. … It is unlikely that the cable, when under normal operating tension, could have been incorrectly positioned, due to the force required. Although it could not be determined when the cable was placed over the [J-shaped] floor-support beam, it is likely that it occurred during the scheduled maintenance inspection when tension on the control-cable system was released.”

The operator issued a maintenance memo noting the importance of observing standard work practices when working with cables or in the area of cables; instituted training on standard work practices when changing cables or releasing tension on cables; and inspected the elevator-cable configurations of the other B-737s in the fleet.

## High-cycle Fatigue Cited in Uncontained Engine Failure

At an altitude of about 670 feet above ground level after takeoff from Jersey Airport, Channel Islands, U.K., an uncontained engine failure occurred to the left engine of a Fokker F.27 Mk 500 Friendship turboprop airplane. The left-engine fire warning activated and flames were seen outside the nacelle. The captain ordered the left-engine propeller to be feathered, the fuel shut off and the fire extinguisher activated. The fire warning ceased.

The captain declared “mayday,” an emergency condition, and conducted a climb to 1,500 feet. The crew told the airport tower operator of the situation, and the aircraft was flown on a single-engine visual approach to an uneventful landing. There were no injuries to the crew of three on the otherwise empty positioning flight on June 5, 2001.

The report by the U.K. Air Accidents Investigation Branch, published July 9, 2004, said, “The engine failure was caused by a high-cycle-fatigue (HCF) cracking of the high-pressure turbine (HPT) disc. … The evidence showed that part of the left-engine HPT disc separated while the engine was operating at takeoff power and that the engine disruption was fully consistent with the effects of this separation.”

Examination showed that two fatigue cracks had developed in the inner blend radius between the diaphragm of the HPT disc and the arm of the rear seal of the Rolls-Royce Dart RDa7 engine. The report said, “The cracks had collectively progressed circumferentially for approximately seven inches [18 centimeters], or around 40 percent, of the circumference, and axially through about 80 percent of the disc thickness. The evidence indicated that, at this point in the propagation of the cracks, the disc was sufficiently weakened for normal operating loads to extend the crack approximately radially from either end. This fractured the remaining 20 percent of the section, thus releasing a substantial portion of the disc, with consequent severe disruption to the powerplant and nacelle."

The Dart engine was an early design, essentially a 1950s model, the report said. Five similar Dart HPT failures had occurred during the previous 29 years. The report said that most of those accidents had been attributed to "a combination of turbine-entry-flow distortion and turbine-blade wear, and the engine manufacturer and the CAA had concluded that the likely period before recurrence of failure was such that additional remedial action was unnecessary."

The most recent prior Dart HPT failure had occurred on March 30, 1998. Immediately after takeoff from London (England) Stansted Airport, on a flight with 40 passengers and four crewmembers, an uncontained failure of the Hawker Siddeley HS-748's right engine resulted in a sudden power failure and a serious engine-bay fire. The captain landed the aircraft on the runway. The aircraft overran the paved surface, and the nose landing gear collapsed. After the aircraft had come to rest, with the engine-bay fire continuing, the crew conducted an emergency evacuation with no serious injuries.

The report said, "Following the necessarily protracted study, testing and analysis [of the Stansted accident] by the engine manufacturer, the evidence collected then indicated that a small gap, under [operating] conditions, between the seal-arm abutment faces of the HPT and intermediate-pressure turbine (IPT) discs could result in high cyclic stresses being present in the HPT seal-arm radius at the disc diaphragm, and that these stresses could result in [HCF] cracking."

As a result, a manufacturer's service bulletin (SB) was issued in April 2001 and a CAA airworthiness directive mandated compliance with the SB. "This [SB] modified the HPT to ensure that a positive interference or 'nip' would exist between the HPT and IPT disc-seal-arm abutment faces, as this was found to significantly reduce such damaging cyclic stresses," said the report. "The compliance date of this SB was 'not later than [Dec. 31,] 2005.'"

Following the HPT disc failure of the aircraft taking off at Jersey, which had not yet undergone the required modification, the SB was changed. Its requirements currently are based on flight cycles, with the highest-cycle discs being removed from service first, and with a compliance end date of June 30, 2004.

## Nosewheel-steering Clutch Fault Causes Runway Excursion

After the Swearingen SA-226T Merlin III was landed, the pilot applied brakes and used the nosewheel tiller for steering. The aircraft veered right and the pilot lost directional control. The aircraft exited the right side of the runway and struck a ditch, and the nosewheel collapsed. The pilot and the one passenger were not injured in the Feb. 28, 2004, accident at Collegedale, Tennessee, U.S.

"Examination of the flight control system, brakes and reverse thrust revealed no anomalies," said the report by the U.S. National Transportation Safety Board (NTSB). "Examination of the nosewheel steering revealed [that] the steering clutches were not grounded, and the grounding stud for the clutches [was] loose."

The left-side console wiring was required to be inspected during the most recent "B" check on Dec. 17, 2002, the report said, but no work sheets for the inspection were found and a review of the logbooks indicated that no maintenance had been performed in that area. The aircraft had undergone an "ABCD" inspection 29.1 flight hours before the accident. (The repair station's inspection procedures manual said, "If an aircraft has been stored or is operated less than 200 flight hours within a 12-calendar-month period, all four letter checks must be accomplished by the end of the 12th calendar month since the last completed letter-check inspection was accomplished in accordance with [U.S. Federal Aviation Regulations Part] 91.409 [*Inspections*].")

The report said that the probable cause of the accident was "the pilot's inability to maintain directional control due to the inadequate grounding of the nosewheel-steering clutches, as a result of inadequate maintenance inspection by … maintenance personnel to ensure [that] the nosewheel-steering clutches were grounded."

## Manufacturer Recommendation Overlooked While Aircraft in Long-term Storage

The British Aerospace ATP turboprop airplane, operating as a cargo flight, was at flight level (FL) 190 (about 19,000 feet) above Mariehamm, Sweden, on Jan. 31, 2003, when a total power failure occurred in the right electrical system. All flight instruments and navigation instruments on the right side failed.

"On the instruments, the pilots saw that the right 28-volt DC [direct-current] system was without voltage, and the right battery was no longer connected," said the report by the Swedish Accident Investigation Board.

The pilots contacted air traffic control and requested a clearance to return to Stockholm-Arlanda Airport, Sweden, from which the flight had departed. "By transferring the right-side AC [alternating-current] load to the left-side AC system, the function of the right EFIS [electronic flight instrumentation system] was regained," said the report. [Each of the aircraft's separate left and right electrical systems has a generator, a 28-volt DC system and a 115-volt, 400 hertz AC system. The generators produce AC current, which is converted by two transformer rectifier units (TRUs) to 28-volt DC current. The DC systems are powered both from the TRUs and from the batteries through a type of relay called the reverse-current circuit breaker (RCCB).] The landing was uneventful, and neither pilot, the airplane's only occupants, was injured.

The aircraft manufacturer had issued a service information leaflet (SIL Ref. 24.010) in October 1999 that warned of a failure risk because of the faulty functioning of the RCCB. Operators were advised to replace an early version of the RCCB (Mod A) with a later version (Mod B), which was said to be more reliable. "The RCCBs Mod A were not replaced [by] Mod B in the [incident] aircraft," said the report. "The reason for this is suggested to be that the aircraft was in long-term storage at the time when SIL Ref. 24.010 was issued. Neither the [current] operator nor the previous operator was aware of it."

The incident was caused by "two independent faults, one of which was the RCCB," said the report. "The loss of [the right] battery power, however, cannot be fully explained, although several possible scenarios have been discussed, of which one [is] a temporary fault in another RCCB."

The operator, in consultation with the manufacturer, subsequently initiated a program to upgrade the aircraft's electrical system. The program included replacing all Mod A RCCBs with Mod B RCCBs, introducing operating-time limitations for RCCBs and shortening the operating time interval for batteries, the report said.

## Failed Tail-rotor Cable Reveals Flawed Record Keeping

The Enstrom F-28C helicopter, on an instructional flight, sustained minor damage when a tail-rotor cable failed about 200 feet above ground level during final approach to an airport at Lapeer, Michigan, U.S. The instructor and student were not injured in the Oct. 22, 2003, incident.

"A post-incident inspection revealed that the cable connecting the right anti-torque pedal to the tail-rotor assembly had failed," said the report by the U.S. National Transportation Safety Board (NTSB). "The failure occurred at the pulley installed immediately forward of bulkhead [no.] 5, located in the tail boom of the helicopter. The opposite cable, connecting the left anti-torque pedal to the tail-rotor assembly, showed signs of wear at the corresponding location."

The incident helicopter was certified originally with a fairlead configuration at the point at which the tail-rotor control cables pass through the aft bulkhead, the report said. [A fairlead is a rubbing block or guide to prevent a cable that is under tension from wearing excessively or cutting into the adjacent structure. Fairleads are used where there is no change in direction of the cable.]

The pulley configuration on the incident aircraft was a modification of the original design, prompted by indications of accelerated cable wear at the fairleads. "This pulley configuration was installed on the incident aircraft as a field modification, reportedly in December 2000," said the report.

The airframe logbook of the incident aircraft revealed no entry concerning installation of pulleys, and no copy of U.S. Federal Aviation Administration (FAA) Form 337, *Major Repair and Alteration*, was found in the helicopter's maintenance records or airworthiness records, the report said. A copy of the form is required by U.S. Federal Aviation Regulations (FARs) Part 43, Appendix B, to be submitted to the aircraft owner and the FAA Flight Standards District Office following a major airframe alteration, which includes the control system.

"A review of [FAA] records revealed no supplemental type certificates on file authorizing retrofit to the pulley configuration," said the report.

The helicopter manufacturer had released a service bulletin on March 6, 2000, requiring operators of Enstrom models F-28F, 280F and 280FX to inspect the tail-rotor cables. Because the incident helicopter was an F-28C, the inspection was not applicable and was not performed. Enstrom reissued the service bulletin on Dec. 9, 2003, including earlier models that have been modified to incorporate the pulley configuration.

"Several FAA service difficulty reports related to wear of the tail-rotor cables have been filed by [maintenance technicians]," said the report. "Reports indicated [that] replacement of cables at 300-[hour] to 400-hour intervals has been required due to wear."♦

## Infrared Heat Suits Hangars

The supraSchwank series of infrared heaters from Schwank combines high efficiency and temperature control for aircraft hangars and maintenance buildings, the manufacturer says.

The supraSchwank heater is said to be suitable for hangars with ceilings as high 60 feet (18 meters) because it can radiate heat to specific areas, such as those occupied by aircraft and technicians, without the heat being dissipated in the upper reaches of the structure. Operating costs are approximately 60 percent less than forced-air heaters, and equipment costs are comparable to those for forced-air heaters and significantly less than for in-floor radiant heat, the manufacturer says.

The supraSchwank heater is a gas-fired or propane-fired appliance that heats patented ceramic tiles within a burner enclosure. This combination is said to contribute to heat recovery within minutes of closing large hangar doors.

For more information: USA-Schwank Heaters, 2 Schwank Way at Highway 56N, Waynesboro, GA 30830 U.S. Telephone: +1 (706) 554-6191; Schwank Heaters, 5285 Bradco Way, Mississauga, ON L4W 2A6 Canada. Telephone: +1 (905) 712-8336.

## They're Under Your Spill

The ribbed bottoms of Ultra-Utility Trays are designed to elevate containers above any spillage or leakage, as well as to prevent fluids from forming a slippery or damaging residue on the shop floor.

*Utility Trays*

The trays, manufactured from polyethylene, are stackable for storage. The product is available in five sizes, from 12 inches by 48 inches by 4.75 inches (30 centimeters by 122 centimeters by 12 centimeters) to 36 inches by 36 inches by 4.75 inches (91 centimeters by 91 centimeters by 12 centimeters) inside diameter.

For more information: UltraTech International, 11542 Davis Creek Court, Jacksonville, FL 32256 U.S.

Telephone: 1 (800) 353-1611 (U.S.); +1 (904) 292-1611.

## Strike Up the Bond

The WichiTech HB-2 is a portable hot-bonder system that repairs metal, Kevlar, carbon, boron and fiberglass. The 35-pound (16-kilogram) unit is programmed using menu-driven functions that can be selected with a single keystroke.

The product has two operator-programmable, independent heating zones and two individual, adjustable vacuum zones. A digital display is complemented by two color-coded printers. Thermocouples, audible alarms, circuit breakers and a ground-fault circuit interrupter provide safety and equipment protection.

For more information: WichiTech Industries, Oakland Center, 8980-L Route 108, Columbia, MD 21045 U.S. Telephone: 1 (800) 776-4277 (U.S.); +1 (410) 715-1076.

## Cleaner Makes a Material Difference

A single product for multiple cleaning and degreasing applications, Orison SC Aircraft and Metal Cleaner is described by the manufacturer as nonreactive and noncorrosive, containing no salt-based chemicals, glycol ethers, terpenes or petroleum solvents. The cleaner is designed to be used on aircraft exterior materials and interior materials and parts, including aluminum, magnesium, plastics, wiring, painted surfaces and upholstery.

The cleaner's formula is readily biodegradable, does not react with other chemicals to create hazardous conditions and requires no personal protective equipment or handling precautions, the manufacturer says. It is nonflammable and can be stored indefinitely.

For more information: Orison Marketing, 17 Windmill Circle, Abilene, TX 79606 U.S. Telephone: +1 (325) 692-1135.


*Aircraft and Metal Cleaner*

## Unit Takes Measures to Ensure Accuracy

Actiris350 is a coordinate-measurement machine quality-control system that checks the dimensional and geometric accuracy of parts, equipment or complex machinery. The unit is portable, weighing 37.5 pounds (17 kilograms), and the absence of wires between its lightweight probe and the measurement device allows the user freedom of movement.

*Coordinate-measurement Machine*

The technology is based on a combination of advanced photogrammetry (the science of obtaining reliable measurements by photography) and digital-image processing. The manufacturer says that Actiris350 provides accurate results combined with speed of measurement.

The system includes an optical head, ergonomic probe, tripod and wheeled transportation case. It is generally sold with Delcan PowerInspect software but is designed as an open platform and can be used with most industrial-measurement software packages, the manufacturer says.

For more information: ActiCM, 122, Rue de la Roche de Lorzier, 38430 Moirans, France. Telephone: +(33) 4 76 91 37 60.

## Headwear Makes Job Lighter

A hands-free personal lighting system, the HeadsUp Lite series from Pelican uses light-emitting diodes (LEDs) and offers three brightness levels and a flashing mode. The LED module is powered by three "AA" alkaline batteries housed in a separate, strap-mounted o-ring pack, and a battery indicator displays the battery status. One set of batteries provides three hours of light at 100 percent power and 24 hours of light at 25 percent power.

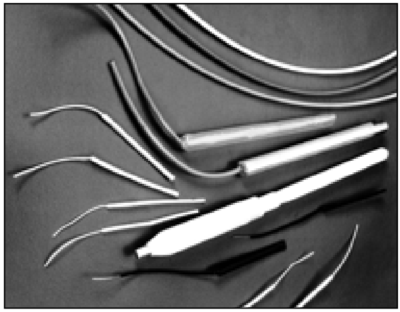
The cloth and rubber straps are designed to adjust easily so that the light and battery pack fit comfortably on the user's head, with the battery pack

*Personal Lighting System*

positioned at the back to provide balance. The lighting head pivots to direct the beam. The unit weighs 0.4 pounds (0.19 kilograms).

For more information: Pelican Products, 23215 Early Ave., Torrance, CA 90505 U.S. Telephone: 1 (800) 473-5422 (U.S.); +1 (310) 326-4700.

## Irregularities Can Be Treated by Shrink



*Heat-shrinkable Tubing*

TexFluor heat-shrinkable tubing can be easily fitted over irregularly shaped and tapered fittings and other protrusions; when heated it shrinks to conform to the object and to provide a protective covering of PFTE (polytetrafluorethylene). PTFE is an inert and durable material with a wide temperature tolerance and resistance to most chemicals, solvents, water and acids. The manufacturer recommends the tubing for aircraft harnesses, probes and temperature sensors.

TexFluor shrinks in a 4-to-1 ratio and is available in standard sizes ranging from 0.078 inch (1.98 millimeters) inside diameter (expanded) to two inches (51 millimeters) inside diameter (expanded). It can be supplied spooled or cut to length.

For more information: TexLoc, 4700 Lone Star Blvd., Fort Worth, TX 76106 U.S. Telephone: 1 (800) 423-6551 (U.S.); +1 (817) 625-5081.

## Pressure Is on View

The Druck DPI 705 handheld pressure indicator is designed for single-handed operation and features a high-resolution liquid-crystal display (LCD). The unit's display can be presented in 16 user-chosen pressure units, both English and metric. Among the available tests are maximum/minimum readings, a 60-second leak test and a 10-reading rolling average for unstable pressures.

The unit is powered by three "AA" alkaline batteries. Features include a high-pressure alarm, an ambient temperature reading in Fahrenheit or Celsius, and a low-battery indicator and selectable "power off" setting for power management.

For more information: Druck, 4 Dunham Drive, New Fairfield, CT 06812 U.S. Telephone: +1 (203) 746-0400; Fir Tree Lane, Groby, Leicester LE6 0FH U.K. Telephone: +(44) (0)116 2317100; other locations worldwide.♦

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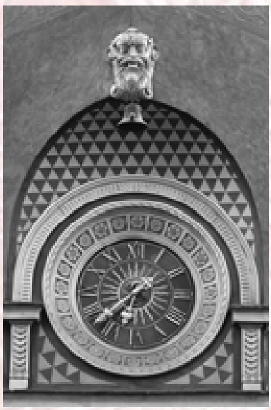
# *Safety, A Common Culture*

## *March 14–16, 2005*



Sheraton Warsaw Hotel & Towers

## *Warsaw, Poland*

To receive agenda and registration information, contact Ahlam Wahdan,
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