FLIGHT SAFETY FOUNDATION
Aviation Mechanics Bulletin

MAY–JUNE 2005

Greasing Errors Cited in B-747 Landing Gear Fires

FLIGHT SAFETY FOUNDATION
SINCE 1947

FLIGHT SAFETY FOUNDATION

Aviation Mechanics Bulletin

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

Robert A. Feeler, editorial coordinator

May–June 2005 **Vol. 53 No. 3**

On the cover: Post-accident examination of this Boeing 747 wheel axle revealed that an incorrect type of grease had been used. (Photo: Australian Transport Safety Bureau)

What's Your Input?

In keeping with FSF's independent and nonpartisan mission to disseminate objective safety information, Foundation publications solicit credible contributions that foster thought-provoking discussion of aviation safety issues. If you have an article proposal, a completed manuscript or a technical paper that may be appropriate for *Aviation Mechanics Bulletin*, please contact the director of publications. Reasonable care will be taken in handling a manuscript, but Flight Safety Foundation assumes no responsibility for material submitted. The publications staff reserves the right to edit all published submissions. The Foundation buys all rights to manuscripts and payment is made to authors upon publication. Contact the Publications Department for more information.

Subscriptions: One year subscription for six issues includes postage and handling: US$160 for members/ US$280 for nonmembers. Include old and new addresses when requesting address change. • Attention: Ahlam Wahdan, membership services coordinator, Flight Safety Foundation, Suite 300, 601 Madison Street, Alexandria, VA 22314 U.S. • Telephone: +1 (703) 739-6700 • Fax: +1 (703) 739-6708

Greasing Errors Cited in B-747 Landing Gear Fires

The report by the Australian Transport Safety Bureau said that excessive amounts of grease had been applied to the landing gear axles and that some of the grease was an incorrect type.

—

FSF Editorial Staff

At 0511 local time July 2, 2003, after a flight from Singapore, the crew of a Qantas Airways Boeing 747 conducted a landing at Sydney, Australia. After arrival at the gate, a "BRAKE TEMP" advisory message illuminated and a fire ignited on the right-wing landing gear. Two more fires subsequently ignited on the right-body landing gear. The airplane received minor damage, and four of the 368 people in the airplane were seriously injured during the emergency evacuation.

The Australian Transport Safety Bureau said, in a report issued March 17, 2005, that significant factors in the accident included the following:[1]

- "Incorrect grease of a lower flash point [temperature at which grease vapor ignites] was applied to the landing gear axles during maintenance;
- "Excessive amounts of grease were present on landing gear wheels and brake voids;
- "The worn brake units generated a higher peak temperature over a short time frame; [and,]
- "The inadvertent de-selection of reverse thrust during the landing roll resulted in increased auto-brake [application] and manual brake application."

Other significant factors included the flight crew's failure to detect the de-selection of reverse thrust and their decision to use a taxiway that minimized the taxi distance and therefore required additional manual braking during the latter portion of the landing roll. The shorter taxi distance to the terminal reduced the effective brake-unit cooling time.

ARFF Found Smoke, No Flames

The first fire, on the no. 13 wheel, produced flames that reached a height of 20 centimeters (eight inches) above the top of the tire and a substantial amount of smoke, the report said. When aircraft rescue and fire fighting (ARFF) personnel arrived four minutes after activation of the alarm, they found "a large amount of smoke … in the right landing gear area" but no flames.

While ARFF personnel were still in the area, the second fire ignited on the no. 9 wheel and was extinguished with chemical dry powder. A subsequent review of a surveillance video revealed that the third fire — a flash fire that burned itself out — occurred on the no. 12 wheel.

Qantas Was Airplane's Only Operator

The airplane had been operated by Qantas since its manufacture in 1999. The airplane's brakes were self-adjusting, hydraulically actuated, multiple-disc brakes, each with four rotor discs and three stator discs made of carbon. Two indicator pins on each brake unit measured brake wear. During assembly, the indicator pins were set at a predetermined protrusion length with hydraulic pressure applied; with wear, the extent of indicator pin protrusion decreased. When the protrusion length decreased to a predetermined length, the brake unit was replaced.

Because the crew had requested additional fuel in Singapore in the event of holding at Sydney or a diversion to Brisbane, the airplane had an estimated landing weight of 270,700 kilograms (596,785 pounds), about 15,000 kilograms (33,069 pounds) less than the maximum allowable landing weight.

About 0508, the flight crew began the instrument landing system approach to Runway 34L at Sydney. The airplane encountered a tailwind, and a controller at the airport air traffic control tower said that surface winds were from 180 degrees at 14 knots — a tail wind component of 13 knots, which was within the airplane's landing limitations.

The crew planned to exit the runway at Taxiway G and set the automatic wheel brakes to position three. (The automatic braking system provided six settings [RTO, 1, 2, 3, 4 and MAX] to allow the crew to select a specified deceleration rate for the landing roll. The setting provided for automatic adjustment of brake torque to achieve the specified deceleration rate. The report said that, for example, if reverse thrust was not used, the system automatically would require higher brake torque.) The landing reference speed for the landing weight and 30 degrees of flaps was 150 knots.

The report said that a setting at position three was "appropriate" for landing conditions at the time and that the landing distance before Taxiway G of 2,826 meters (9,272 feet) was "more than adequate."

The airplane touched down 430 meters (1,411 feet) beyond the runway threshold at 164 knots, with a tailwind of about 12 knots. The report said that the landing was normal, the spoilers deployed automatically, and the automatic braking system activated. About five seconds after landing, with an indicated airspeed of 150 knots, the copilot (the pilot flying) selected reverse thrust levers to the "idle reverse" position. (The crew had decided earlier in the flight to select the "idle reverse" position because of restrictions in effect during the airport's overnight curfew period.)

The captain verbally reminded the copilot to use "no more than idle reverse" and also placed his hand over the copilot's hand on the thrust lever to ensure that the copilot did not move the reverse thrust levers beyond the idle reverse setting. Recorded flight data showed that the reverse thrust levers were moved to the idle reverse detent.

Crew Did Not Detect De-selection of Thrust Reversers

Nevertheless, the report said, "Before any of the reversers reached the fully deployed position, and within two seconds of selection, the reverse thrust levers returned to the retracted position and the thrust reversers began to retract. The aircraft's speed at that time was 136 knots. None of the crewmembers reported noticing that the thrust reversers had de-selected, and the engines remained at forward idle thrust for the remainder of the landing roll.

"As the aircraft decelerated through 100 knots, the [captain] assessed that a higher rate of deceleration was required to allow exiting the runway at Taxiway G. He directed the copilot to disarm the automatic wheel brakes and to apply manual braking. The copilot took those actions, reducing the aircraft's speed to approximately 10 knots by the Taxiway G turnoff."

The captain taxied the airplane to the gate, and the flight crew told the cabin crew to disarm the doors, then observed the "BRAKE TEMP" message on the engine indicating and crew alert system

(EICAS) display screen. At the same time, they observed on the secondary EICAS display screen an "amber five" indication for the wheel-brake temperature on wheel no. 12 on the right-body landing gear. (An "amber five" indication meant that the temperature had reached 482 degrees Celsius [900 degrees Fahrenheit] — within the brake unit's operating range.)

Ground Personnel Observed First Fire

After the wheel chocks were in place, the copilot told ground personnel about the "hot brakes" indications, and other ground personnel observed the fire in wheel no. 13. Passengers already had begun exiting through door L1 to the airbridge when the captain ordered emergency evacuation of the airplane, and evacuation slides were deployed at eight locations. One of the eight evacuation slides deflated while in use; another slide landed on a baggage-handling vehicle and was not used for passenger evacuation.

A preliminary examination of the landing gear revealed no damage other than soot. The no. 9 and no. 13 wheel and brake units contained pelletized grease and "evidence of fire"; the no. 12 wheel was undamaged other than the possible indications of the flash fire, the report said.

After wheels no. 9 and no. 13 were removed, the axles were examined. In addition to Aeroshell 22, the correct grease, which is amber in color, a green-blue grease, later identified as Aeroshell 33, also was found.

"Although not recommended for use in the high-temperature axle area as it had a lower flash point than the approved Aeroshell 22 grease, Aeroshell 33 was an approved lubricant for other areas of the landing gear," the report said.

Most of the Aeroshell 33 grease was found on the inboard area of the axle; Aeroshell 22 was visible on the outer area.

After the discovery of Aeroshell 33 on these two axles, the operator inspected all other axles on the airplane; Aeroshell 33 also was found there.

"It was also noted that an excessive amount of grease was present on the axles and in the brake-unit cavities," the report said. "The lubrication of the landing gear axles and brake unit interface was required whenever the wheels or brakes were replaced. Brake units were also lubricated during the more detailed landing gear lubrication process."

Manufacturer Warned Against Excess Grease

Boeing maintenance procedures for removal and installation of brakes and wheels included cautions against the application of too much grease.

An examination of this wheel axle from the accident airplane revealed two different types of grease — near the top of the photo, Aeroshell 33, not approved for use in this part of the landing gear; and near the bottom of the photo, the approved Aeroshell 22. (Source: Australian Transport Safety Bureau)

The following warning accompanied maintenance instructions for removal/installation of the hydraulic brake system:

> Warning: Apply a thin layer of grease to the interface surfaces of the brake and axle only. Do not apply grease in the space between the axle bushings on the brake assembly. If you apply too much grease, a fire can occur when the brake becomes hot.

The following caution accompanied maintenance instructions for removal/installation of main landing gear tire/wheel:

> Caution: Do not apply grease to the area between the axle bearings. The high temperatures in this area during a landing can cause all grease in the area to burn. This can cause damage to the wheels, tires and brakes.

In both instances, the procedures called for excess grease to be removed with a rag.

A more extensive inspection of the no. 9 wheel and the no. 13 wheel found that the fires had not resulted in sufficient heat to blister the tire surfaces or melt their fusible plugs — safety plugs in the wheel hubs designed to melt at a predetermined temperature and prevent explosive air release.

"There was a substantial amount of old grease and general debris on the inner rim of both wheels, which — although not uncommon — was excessive," the report said.

No defects were found in the wheel bearings, which were packed with the correct Aeroshell 22 grease.

The inspection revealed "dark, discolored grease that could not be easily identified" within the bushing of the no. 9 brake unit, the report said. The wear-pin indicator was within the serviceable range, but the heat stack (the stator discs and rotor discs in the brake unit) was "considerably worn." In addition, there was excessive grease on the inner face of the brake unit.

The no. 13 brake unit bushing contained "a very small amount of green-blue grease identified as Aeroshell 33 within the brake unit," the report said. The wear-pin indicator was within the serviceable range, but the heat stack was "considerably worn."

Maintenance records showed that lubrication of the landing gear and wheel/brake changes were performed at several locations, including Qantas maintenance facilities and external maintenance facilities. There had not been recent maintenance that required lubrication of the axles of the affected wheels. The records showed that the no. 9 wheel was installed on the airplane in June 2003 and the corresponding brake unit was installed in November 2000; the no. 13 wheel was installed in May 2003, and its brake unit was installed in March 2000.

The investigation revealed that in November 2000, a brake fire occurred on another Qantas B-747-400 soon after maintenance. The wheel interior and brake void contained an "excessive amount of grease, including Aeroshell 33," the report said. After that incident, Qantas issued a safety alert bulletin to the maintenance facility that had performed the maintenance.

On July 3, 2003 — one day after the accident — another Qantas B-747-400 experienced a brake fire after landing with an eight-knot tailwind on Runway 34L during the curfew. The fire had burned itself out before ground personnel used a fire extinguisher. During an examination of the landing gear, Aeroshell 33 and "excessive" grease were found around the wheel and brake unit, and the brake unit was worn and was nearing the end of its service life.

After the July 3, 2003, fire, the operator inspected its B-747 fleet and found that two airplanes — the accident airplane and the airplane involved in the July 3 fire — had the incorrect type of grease on their landing gear axles as well as excessive grease. One other airplane "showed signs of excessive grease." Aeroshell 33 was not found on the axles of any other airplanes.

As a result, Qantas issued maintenance memo M0429-GEN-32-41-JUL 10/03, which discussed precautions to be taken in lubrication of wheel and brake assemblies and warned against the use of Aeroshell 33 grease on landing gear axles.

Procedures Required Wiping Away Excess Grease

The report said that Qantas "followed the manufacturer's lubrication procedures, which listed four different types of grease to be used on the landing gears.

"Although the manufacturer's procedures contained diagrams that clearly showed the locations to apply the appropriate lubricant, maintenance personnel worked from the operator's work sheets that give general details of components to lubricate, all materials to be used and a reference to the manufacturer's maintenance manual (for access to the lubrication diagrams), requiring personnel to independently obtain the relevant drawings. Both the aircraft manufacturer's [maintenance procedures] and the operator's maintenance procedures included the instruction to wipe away any excess grease after lubrication had been carried out."

Of the numerous maintenance facilities that performed tasks involving landing gear lubrication, all were accredited, but their procedures varied for the handling of lubrication equipment.

"Some facilities held pneumatic grease guns in a central store [and the grease guns] were issued on request," the report said. "These guns connected directly to the top of large grease tins. Other locations issued hand-held manual grease guns, which were filled from the larger tins, or used cartridges of grease. It was not uncommon for individual maintenance crews to hold their own grease guns on their work trolleys. Both Aeroshell 33 and Aeroshell 22 grease had been supplied to the operator in large tins that were identical in color; however, after the accident, the operator changed procedures to ensure that Aeroshell 33 grease was obtained in clearly marked cartridges. Supply of Aeroshell 22 grease remained in the large tin form. The method of identifying equipment was a combination of color-coding and ID [identification] tag identifiers, but not all equipment in use was clearly marked."

Approach Was Within Operational Parameters

Based on information provided to the flight crew during the approach, the crew conducted an approach that was "well within [the airplane's] operational parameters," the report said. "The tailwind and high landing weight of the aircraft did, however, result in a higher groundspeed on touchdown."

The captain's action in placing his hand over the copilot's hand on the thrust lever may have led to the inadvertent de-selection of the reversers, the report said.

The de-selection of the reversers, along with the crew's selection of a taxiway that allowed them to minimize taxiing time, resulted in application of additional manual braking — and additional heat in the brake units. Because of the relatively short taxiing distance, the time for dissipation of heat in the units was reduced.

(The braking process generates heat because of the friction inherent in the process. The heat is dissipated through the brake discs and into the atmosphere.

"The amount of energy required by a brake unit to slow or stop an aircraft of a given weight, traveling at a given speed, within a given deceleration rate is the same for a new brake unit as for a worn one," the report said. "However, the heat generated in dissipating that energy would be greater in a worn brake unit due to its reduced mass.")

The investigation did not determine when the Aeroshell 33 grease had been applied to the main landing gear axles.

"The most likely event would have been during scheduled lubrication maintenance, not during individual wheel/brake replacement," the report said. "The location of the Aeroshell 33 grease on the inner area of the axle suggested it had been present for some time."

In addition to the accident airplane and the airplane involved in the July 3, 2003, incident, two other airplanes in the fleet "showed signs of excessive or incorrect grease on their axles," the report said. All airplanes had undergone maintenance that required axle lubrication at the same maintenance facility at about the same time.

"The reason for the application of Aeroshell 33 to the landing gear axles could not be determined but may have been the result of maintenance personnel not following work procedures correctly, the use of incorrect lubrication equipment or the use of the correct equipment that had been filled with the incorrect grease," the report said.

Excess grease was found on the landing gear of a number of the operator's airplanes, the report said.

"Maintenance procedures, including the operator's work sheets, instructed the wiping away of excess grease after lubrication," the report said. "Previous maintenance had not complied with that instruction. Failure to remove the excess grease after lubrication tasks led to its buildup around the wheels and brake units, presenting the potential fire hazard. The aircraft manufacturer's maintenance manual issued warnings of this potential [hazard]."

The report said that the presence of Aeroshell 33, with its lower flash point, and excessive amounts of grease on the landing gear axles "may have led to a condition where a fire could initiate under normal brake-operating temperatures. All wheel axles contained the incorrect grease in excessive amounts and were subjected to the same braking forces; however, only three [wheel axles] actually ignited.

"The sequence of fire ignition was not consistent with the varying temperatures of the wheels, as recorded on the EICAS synoptic screen and the aircraft's quick-access recorder. Therefore, the quantity of grease and the peak temperatures reached by the brake units were critical factors for ignition."

Changes Require Color-coding

After the accident, Qantas implemented several safety actions, including the following:

- "Aeroshell 22 [grease] and Aeroshell 33 grease are now obtained in uniquely identified cartridges. All grease-application equipment and their storage containers are now clearly identified through color-coding and labeling specific to the grease type;

- "Maintenance memo M0429-GEN-32-41-JUL 10/03 has been issued to highlight the hazards and precautions to be taken when carrying out wheel [lubrications] and brake-assembly lubrications;

- "Training videos from grease manufacturers have been sourced, and operator's newsletters have been issued to further educate the workforce; [and,]

- "A review of the aircraft maintenance manual, chapters 12 (landing gear lubrication) and 32 (wheel and brake removal/installation) was carried out to ensure the correct greases are specified and that appropriate warnings are listed."♦

[FSF editorial note: This article, except where specifically noted, is based on Australian Transport Safety Bureau Investigation Report BO/200302980, *Boeing 747-438, VH-OJU, Sydney Aerodrome, NSW, 2 July 2003*. The 37-page report contains illustrations and an appendix.]

Note

1. Other sections of the accident report discussed problems in the emergency evacuation. The report cited several significant factors related to the evacuation and the slide failure, including:

   - "Passengers standing in the aisles with cabin baggage at the time of the evacuation announcement caused congestion;
   - "A number of passengers evacuated down the slide in possession of their cabin baggage and personal belongings;
   - "During passenger evacuation, the R3 slide sustained an overload failure of its fabric fibers when punctured by a blunt-edged object; [and,]
   - "The use of the overwing slides during the evacuation presented passengers with the potential hazard of being placed in close proximity to the fire source."

   As a result of the investigation, Australian Transport Safety Bureau issued two safety recommendations that said that the Australian Civil Aviation Safety Authority and Qantas should "review the adequacy of their procedures for the deployment of overwing slides during brake-fire situations. This review should take into consideration the visual cues used and potential risk to passengers of evacuating within close proximity of a fire zone."

MAINTENANCE ALERTS

Failed Capacitor, Transformer Prompt Emergency Landing

Following takeoff from Hartsfield-Jackson International Airport, Atlanta, Georgia, U.S., the no. 6 display unit on the instrument panel of the Boeing 717-200 went blank. The "LEFT GENERATOR OFF" alert was displayed. The first officer requested radar vectors from the tower. The airplane then had a complete electrical-power failure, after which the emergency backup system restored power.

A flight attendant advised the captain that there was smoke in the aft area of the cabin. The flight crew also detected "an electrical burning smell" and declared an emergency. The airplane was returned to the airport, and an emergency evacuation was ordered on the runway. There were no injuries to the two flight crewmembers, three flight attendants and 116 passengers in the March 5, 2004, incident.

"Examination of the power-conversion distribution unit revealed that the tantalum [a metallic element] capacitor and the permanent-magnet generator-input transformer failed," said the report by the U.S. National Transportation Safety Board (NTSB). "The failed transformer was the apparent source of the smoke in the cabin."

Hose Cracks Before Service-life Expiration

The de Havilland DHC-8 (Dash 8) had just departed from Brisbane, Queensland, Australia, on a scheduled passenger flight to Barcaldine, Queensland. The no. 2 hydraulic-pump "CAUTION" light illuminated, followed by a zero-hydraulic-pressure indication. The no. 2 hydraulic system powered the aircraft's spoilers, parking brakes, nosewheel steering, and landing gear extension and retraction.

The flight crew diverted the flight back to Brisbane and extended the landing gear manually for the landing. There were no injuries or aircraft damage in the Nov. 27, 2003, incident.

"The failure of the hydraulic-system pressure was traced to the failure of a flexible hydraulic hose in the nose landing gear-actuation system, which allowed the loss of system pressure and hydraulic fluid," said the report by the Australian Transport Safety Bureau (ATSB).

The failed hose was sent to an ATSB laboratory for examination. "Examination by the ATSB found the hose had failed by localized rupture at the point of swaged connection to an end fitting," said the report. "Associated with the rupture was evidence of fatigue cracking and breakage of the external reinforcing braid wires, with cracking also found to a lesser degree on the opposite side of the connection. There was no evidence suggesting that a manufacturing or material defect had contributed to the hose failure. Assembly diagrams showed that the hose failed at the point of maximum flexure when the landing gear was extended or retracted."

The hose had been installed during the aircraft's manufacture, and the failure had occurred at 12,369 cycles since new, the report said.

"Failure of the hose was attributed to the localized fatigue cracking and breakdown of the external braided hose-reinforcing sheath and the subsequent rupture of the tubular core in the absence of the support afforded by the sheath," said the report. "In-service flexures of the hose and pressure cycles and pulsations inherent in the operation of the aircraft's hydraulic system were considered to be likely contributory factors."

When first introduced into operation, the aircraft manufacturer had set the hose-life limit at 15,000 flight cycles. But the manufacturer had instituted a life limit of 13,000 flight cycles in response to a history of failure of the same or similar hoses in the Dash 8 landing gear system, the report said.

The hose failed 631 flight cycles before it was due to be replaced in accordance with the aircraft manufacturer's maintenance schedule. Although the service lives of components are based on previously established minimum numbers and maximum numbers of cycles, those limits are not absolute, the report said. "While most of the failures would occur between those limits, there remains a probability that some components may fail before the lower limit, or indeed after the upper limit," said the report.

Compressed-air Line Leak Causes Engine Failure

The Bell 206B JetRanger helicopter was being flown on a positioning flight en route to Aniak, Alaska, U.S., when the engine failed. The pilot initiated an autorotation toward a clearing but was unable to fly the helicopter that far, and the helicopter struck trees about 30 feet above ground level. The pilot, who was the only occupant, had minor injuries in the July 9, 2003, accident.

During the inspection of the engine, the compressor-discharge-pressure line (Pc line) was removed at the compressor scroll. [The Pc line provides compressed air (bleed air) from the compressor section of the turbine engine to operate the fuel-control unit.] Compressed air was applied to the Pc line, and air was found to be escaping from the Pc line at the fuel-control unit because of a loose B-nut.

"There was evidence of fretting on the B-nut fitting, and there were smears of orange torque-seal material on the B-nut," said the report by the U.S. National Transportation Safety Board (NTSB). "No torque-seal material was present on the B-nut fitting."

The engine logbook indicated that the fuel-control unit had been replaced by the operator's technicians 178 flight hours before the accident, the report said.

The probable cause of the accident was given as "the [Pc line] B-nut coming loose at the fuel-control unit, which resulted in a total loss of engine power, and subsequent in-flight collision with trees during an autorotation." An associated factor, the report said, was "the improper installation of the Pc line B-nut by company maintenance personnel."

Overloaded Strand Cited in Clutch-cable Failure

The Schweizer 269C helicopter was in a hover about five feet above ground level after takeoff when the engine speed suddenly increased rapidly and the helicopter swung uncontrollably to the left. The skids touched the ground and dug in, causing the helicopter to topple over. The pilot, the only occupant, was not injured in the May 3, 2002, accident at Lisacul, County Roscommon, Ireland.

"The evidence of the accident is consistent with clutch-cable failure," said the report by the Irish Air Accident Investigation Unit (AAIU). "The effect of cable failure would result in the total loss of friction in the V-belts and consequent disconnection of the engine from its rotor load. [Eight V-belts connect the engine to the main gearbox.] This would result in an immediate overspeed of the engine. … Also, in the hover, the pilot would have had to apply left pedal to counteract the engine torque. When the engine was effectively disconnected suddenly, this pedal caused the helicopter to yaw violently over to the left."

The clutch cable had failed inside the swaged ferrule [a fitting compressed to create a tight grip on the cable] directly underneath the ball terminal in the clutch-control spring assembly, said the report.

"The outer strands of the cable had been twisted in a manner that exposed the core strand," said the report. "This can be caused by twisting of the cable during tensioning, and results in overloading the core strand when the cable is subjected to service loads."

The examination concluded that:

- "The fracture of the cable occurred by overload as a result of unequal strand loading. It is also considered probable that the unequal loading occurred because the cable was twisted during tensioning at the last [V-]belt change;
- "Service loading, under the conditions described above, resulted in the core strand of the cable carrying a disproportionate share of the load;
- "Depending on the degree of twist and the magnitude of the load, fracture can occur (a) immediately [when] a service load is applied or (b) by a high-stress, very-low-cycle mechanism; [and,]
- "If the service loads are low relative to the strength of the cable, fracture will not necessarily occur. It is thought probable that, in this case, condition (b) above applied."

Failed Relay Results in False Warning

The Boeing 747-400 was arriving at Sydney, New South Wales, Australia, at the end of a scheduled passenger flight from Los Angeles, California, U.S. Following the selection of reverse thrust, the flight crew observed a "FIRE" warning message for the no. 2 engine displayed on the engine indication and crew alert system (EICAS) screen.

The flight crew stopped the airplane on a taxiway, conducted the

"Non-normal" checklist and discharged the fire extinguishers for the no. 2 engine. The airport rescue and fire fighting (ARFF) service advised the crew that there was no visible indication of fire in the no. 2 engine. The crew was cleared to taxi to the terminal, where ground engineers examined the engine and confirmed that no fire was present. Embarkation of passengers was normal and there were no injuries in the July 9, 2004, incident.

"Although the 'FIRE' warning message was still displayed on the EICAS screen, a detailed inspection of the no. 2 engine confirmed that the engine had not been subjected to a fire or overheat event," said the report by the Australian Transport Safety Bureau. "Further troubleshooting revealed the failure of an electrical relay installed in the fire/overheat-detection systems test circuit."

The failed relay was installed in the test circuit and was correctly energized when the test circuit switch was depressed, the report says. The contacts then closed, allowing power to reach the automatic fire/overheat-logic test system (AFOLTS) printed circuit cards, initiating the fire/overheat-detection systems test circuit.

The report said, "The internal failure of the relay led to power being supplied to select circuits within the AFOLTS cards without depression of the test switch. That resulted in the no. 2 engine 'FIRE' message displayed on the EICAS screen.

"Following the replacement of the relay, the fire/overheat-detection system was tested with no further faults found, and the aircraft was returned to service."

Heavy Landing Traced To Shifting Fuel Cell

The pilot of the Bell 206B JetRanger observed a momentary power loss during agricultural spraying operations. This was followed by a complete power loss that led to a heavy landing. The pilot, the only occupant, was not injured in the Nov. 26, 2003, incident at Beaumont Station, New Zealand.

The report by the engineering section of the Civil Aviation Authority of New Zealand said, "Engineers found that the fuel cell had moved forward from the rear wall, interfering with the upper fuel-sender unit and causing erroneous indications. The fuel cell was a type applicable to helicopters [with serial numbers] 3567 and subsequent, and it was of a more rigid construction, replacing the use of lacing to retain the tank shape.

"It is recommended that the operators of Bell 206 helicopters [with serial numbers] 3567 and subsequent take steps to ensure the integrity of the fuel-cell installation."

Unclear Instructions Cited in Landing Gear Anomaly

The Fokker F28 was being flown on a scheduled passenger flight from Brussels, Belgium, to London (England) Heathrow Airport. On final approach, the landing gear was selected "DOWN," but the nose landing gear "DOWN AND LOCKED" light failed to illuminate. After visual and aural warnings, the flight crew conducted a go-around and the landing gear was recycled, but the same warnings recurred.

"Consulting with company engineers and carrying out the prescribed procedure for alternate landing gear lowering, the crew were committed to landing the aircraft with a 'NOSE LANDING GEAR UNSAFE' indication," said the report by the U.K. Aircraft Accidents Investigation Branch (AAIB). "The tower at London Heathrow advised the crew that all three landing gear and the main-gear doors appeared to be down. The aircraft [was] landed normally and was slowed using 'emergency maximum' reverse thrust, with normal braking being used only after the groundspeed had decreased to below 10 knots." There were no injuries to the passengers or crewmembers in the Aug. 14, 2004, incident.

"Extensive troubleshooting in the hangar, including testing of the nose landing gear indication system and gear-retraction [and gear-] extension tests, failed to identify any defects," said the report. The aircraft was returned to service and there were no further reports of problems with the extension and locking of the nose landing gear.

Later engineering investigations determined that the aircraft maintenance manual (AMM) procedure for checking the nose landing gear downlock-plunger clearance was probably responsible for the nose landing gear downlock being misrigged when the nose landing gear had been replaced in June 2003.

"The nose landing gear on the Fokker F28 Mark 0100 is of the forward-retracting type," said the report. "The gear is locked in the down position by a spring-loaded plunger mounted on the top of the leg. During gear extension, the plunger contacts a ramp on the downlock bracket, which compresses the plunger into its housing against the force of the spring.

"The downlock bracket is shimmed to ensure that the downlock plunger is located centrally in the hole when the gear is down. If the clearance is incorrect, the downlock plunger may be prevented from fully extending due to the excessive friction caused by the plunger being forced against the side of the hole. If the plunger is not fully extended, the down-and-locked proximity sensors may not be triggered."

In reviewing the AMM procedure for checking the downlock-plunger clearance, the airline's engineering quality department noted that the written procedure was ambiguous. "[The description in the AMM] did not make it clear that it is necessary to apply a rearward force on the nose landing gear when checking the downlock-plunger clearance," said the report. "Failing to do so will result in an incorrect measurement being obtained."

Maintenance Inspection Misses Loose Fitting

At an altitude of 200 feet during takeoff for a maintenance test flight, a power failure occurred to a Robinson R22 helicopter. The pilot conducted an emergency landing on an open field, which was followed by a post-accident fire. The pilot was not injured in the Jan. 19, 2004, incident at Nicholasville, Kentucky, U.S.

The report by the U.S. National Transportation Safety Board (NTSB) said, "Examination of the engine revealed that the main fuel line to the carburetor was separated and sitting just below its 90-degree elbow fitting. The threads of the elbow fitting displayed severe fire damage and downward melting, and the line end of the fitting was filled with melted aluminum.

"The fitting was removed from the carburetor, and it was noted that the B-nut, used to secure the fuel line to [the] elbow fitting, was loose. Additionally, 'tooling marks' were observed on the fitting."

The investigation found that the last 100-hour inspection had been performed on the helicopter on Dec. 9, 2003, about seven flight hours before the accident. "No maintenance was performed on the carburetor," said the report.

U.S. Federal Aviation Regulations (FARs) Part 43, Appendix D, *Scope and Detail of Items (as Applicable to the Particular Aircraft) to Be Included in Annual and 100-Hour Inspections*, requires that an annual inspection or 100-hour inspection shall include "lines, hoses and clamps — for leaks, improper condition and looseness."

The report listed the probable cause of the accident as "a leak in the fuel system due to a loose fitting, which resulted in a loss of engine power, and the inadequate maintenance inspection, which failed to detect/correct the security of the fitting."♦

It's a Wash

The Hotsy 8600 from C-Tech Industries is a single-stage parts washer that uses a steel conveyor belt to carry the parts through a washing tunnel, where the parts are blasted with hot water from a spray manifold. The conveyor belt, made of flat wire mesh, can be adjusted to move at speeds of as much as eight feet (2.4 meters) per minute. Parts are always within 10 inches (25.4 centimeters) of the spray nozzles.

Single-stage Parts Washer

The unit has an automatic fill system for protection against low water levels in the wash tank; locking casters for movement within the shop; a removable debris tray with a mesh screen to prevent pump damage from large particles; a strainer in the plumbing to eliminate nozzle-clogging debris; and various safety features, including enclosure of the main electrical disconnect in a watertight box at the rear of the equipment.

For more information: C-Tech Industries, 4275 N.W. Pacific Rim Blvd., Camas, WA 98607 U.S. Telephone: 1 (800) 525-1976 (U.S.); +1 (360) 834-0983.

Degreaser Sinks Dirt

Biosane cold-degreasing products are designed for rapid removal of grease and oils from mechanical parts. The Biosane products are compatible with all common metals, and the fluids' low densities and high separation powers ensure that pollutants will settle at the bottom of the tank, the manufacturer says.

The range includes 18 fluid varieties to accommodate the user's cleaning and degreasing needs, and products vary by criteria such as evaporation times, solvent power and flash point. All fluids in the line are said to be free from chlorinated compounds.

The environmentally safe product is especially useful for cleaning parts that are to be painted or bonded, the manufacturer says, and can remove temporary-protection oils, inks, adhesives and soaps, as well as more common oils.

For more information: CRC Industries, Wylds Road, Castlefield Industrial Estate, Bridgwater, Somerset TA6 4DD U.K. Telephone: +44 (0)1278 727200.

Notebook-size Unit Spots Joint Flaws

The battery-operated USLT ultrasonic inspection notebook from GE Inspection Technologies is designed as a portable, personal computer–based instrument for nondestructive testing of joints such as spot welds.

The unit can be set up easily using a touch screen, the manufacturer says, and any of 14 function keys can be configured to operate with the software chosen for the application for control independent of the touch screen. The function keys can also be operated by either remote control or by a mouse and keyboard connected via a universal serial bus (USB) port.

A variety of information can be displayed on the high-resolution screen,

Ultrasonic Inspection Notebook

and as many as four selectable measurement values can be shown. An indicator shows the active function group.

For more information: GE Inspection Technologies, 129–135 Camp Road, St. Albans, Herts, AL1 5HL, U.K. Telephone: +44 (0)1727 795513.

Product Makes Adhesives Dispensible

Two-component adhesive application over large dimensions is facilitated by Henkel Corp.'s Loctite Meter Mix Dispense Systems, the manufacturer says. The systems feature fixed-ratio units and variable-ratio units that can be customized by the user.

Adhesive-dispensing System

The Loctite 1000 System uses two positive-displacement piston pumps and is designed for handheld dispensing at distances as far as 10 feet (three meters). The Loctite 2000 system includes a control panel to enable bench-top dispensing and is capable of controlled shot-size dispensing and pressure regulation to modify flow rates. The Loctite 3000 System is operated with programmable shot size and touch-screen controls.

For more information: Henkel Corp., 1001 Trout Brook Crossing, Rocky Hill, CT 06067 U.S. Telephone: 1 (800) 562-8483 (U.S.); +1 (860) 571-5100.

Software Aids Maintenance Management

Project-management software from 4Sight Technologies includes the following products:

- PM Pro, which is said to allow effective management of work requiring collaborative, company-wide project planning "from the top down," while scheduling projects "from the bottom up";
- MCPHPro, which allows a company to take engine, component and auxiliary power unit (APU) maintenance cost-per-hour contract constraints and apply them to business statistics to "plan, forecast and budget the maintenance cost-per-hour expense by asset serial number," says the software developer;
- MXSPro, which allows the user to generate an optimized base-maintenance plan, line-maintenance plan, task plan and component plan for an asset's entire life. Introducing facility parameters, manpower parameters and scheduling parameters, the software developer says, enables the minimizing of asset down time;
- BayPlan, which is designed to enable the user to integrate maintenance management with maintenance-due dates, scheduled items, material requirements, manpower requirements, aircraft-scheduling information, maintenance-facility information and routing information; and,
- CheckPlan, which the software developer says allows the user to optimize maintenance-task flow using "check-flow templates."

For more information: 4Sight Technologies, 14901 N. Scottsdale Road, Suite 302, Scottsdale, AZ 85254 U.S. Telephone: +1 (480) 922-6482.

Fasteners Keep a Low Profile

A range of aerospace fasteners from SPS Technologies features the MOR-TORQ drive system that is intended to improve torque capability while minimizing the risk of damage to the fasteners.

MORTORQ fasteners are said to offer a labor-saving, lighter-weight alternative to easily damaged shallow-head fasteners with poor torque transfer. The fasteners' lower-profile head can reduce material thickness and weight in many joint designs, the manufacturer says.

The MORTORQ spiral-recess concept is intended to enable workers to install and remove panel fasteners and structure fasteners at odd angles without serious muscle stress or fear of damage to surrounding surfaces.

For more information: SPS Aerospace Fasteners, 301 Highland Ave., Jenkintown, PA 19046 U.S. Telephone: +1 (215) 572-3145.

Portable Kit Houses Wire Tools

A portable, compact tool kit includes an adjustable wire stripper, a utility flush cutter and precision cable slitter.

The Xuron TK2300 Wire Harness Tool Kit's three tools, described by the manufacturer as critical for a wide range of wire-harness applications and wire-processing applications, are packed into a triple-fold canvas pouch with pockets to protect each tool and a Velcro closure. The tool kit is designed to fit into a pocket, attaché case, tool box or field-service kit. Two additional smaller pockets store supplementary tools.

For more information: Xuron Corp., 62 Industrial Park Road, Saco, ME 04072 U.S. Telephone: +1 (207) 283-1041.

Laser Marks Aviation Cables

ULYS and MRO 2000 laser cable markers from Laselec are designed to meet the demand for an alternative to identification processes that users consider aggressive (such as hot stamping) or nonpermanent (such as ink-jet marking).

Depending on the model, cable speeds of as much as 394 feet per minute (120 meters per minute) are possible, the manufacturer says. The cutting system is said to be compliant with aviation-industry standards. Features include an automatic smoke-ventilation system, compact ergonomic structure and a user safety hood.

For more information: Laselec, 105 Avenue du Général Eisenhower, BP 1205, 31037 Toulouse Cedex, France. Telephone: +33 (0)5 61 19 46 46; 2012 East Randoll Mill, Suite 210, Arlington, TX 76011 U.S. Telephone: +1 (817) 460-7830.♦

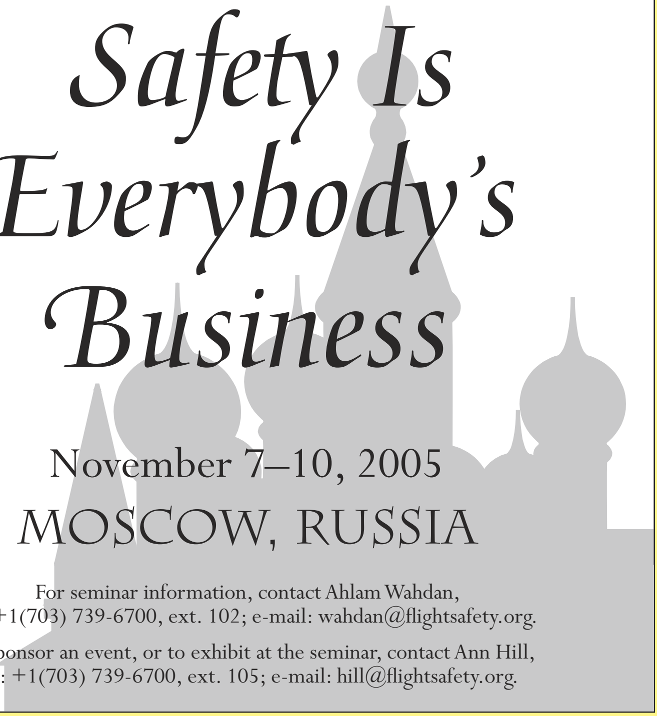
International Federation of Airworthiness

Flight Safety Foundation

International Air Transport Association

SAVE THE DATE!

Joint meeting of the
FSF 58th annual International Air Safety Seminar IASS,
IFA 35th International Conference and IATA



Safety Is Everybody's Business

November 7–10, 2005

MOSCOW, RUSSIA

For seminar information, contact Ahlam Wahdan,
tel: +1(703) 739-6700, ext. 102; e-mail: wahdan@flightsafety.org.

To sponsor an event, or to exhibit at the seminar, contact Ann Hill,
tel: +1(703) 739-6700, ext. 105; e-mail: hill@flightsafety.org.

Want more information about Flight Safety Foundation?

Contact Ann Hill, director, membership and development,
by e-mail: hill@flightsafety.org or by telephone: +1 (703) 739-6700, ext. 105.

Visit our Internet site at <www.flightsafety.org>.