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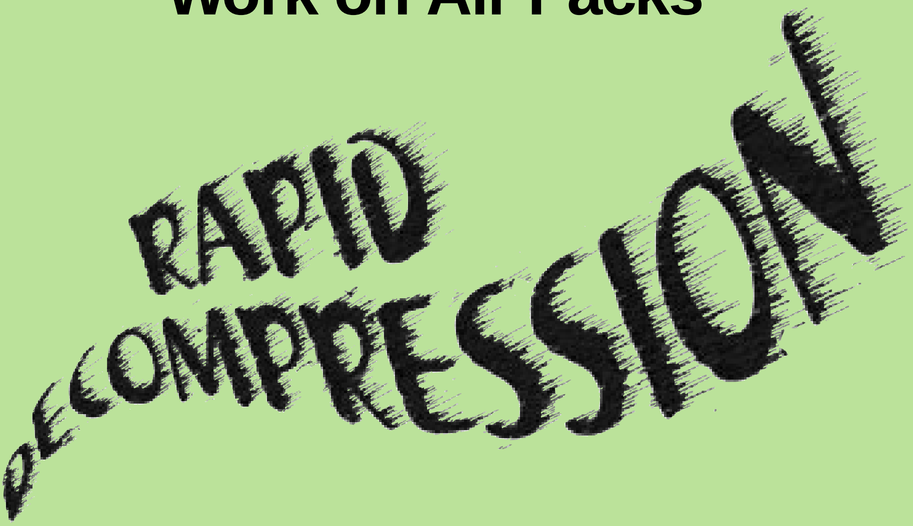
Report on A320 Decompression Faults Maintenance Personnel's Work on Air Packs



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Aviation Mechanics Bulletin

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

Robert A. Feeler, editorial coordinator

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Report on A320 Decompression Faults Maintenance Personnel's Work on Air Packs

The report by the U.K. Air Accidents Investigation Branch said that trouble-shooting failed to detect damage to an air-conditioning pack and that maintenance personnel used an unapproved technique to reattach a disconnected duct.

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FSF Editorial Staff

About 1333 local time June 10, 2000, the crew of an Airbus A320 experienced a rapid decompression as the airplane was flown through Flight Level (FL) 300 (approximately 30,000 feet) following departure from London Gatwick Airport en route to Palma de Mallorca, Spain. The crew donned oxygen masks, conducted an emergency descent and landed the airplane at the departure airport. The airplane received minor damage; none of the 182 people in the airplane was injured seriously, but a number of passengers said that they experienced symptoms typically associated with hyperventilation or anxiety.[1]

In its report, the U.K. Air Accidents Investigation Branch (AAIB) said that the incident — the second decompression incident involving the airplane that day — had occurred one day after problems involving the airplane's no. 2 (right) air-conditioning pack were "inappropriately addressed by maintenance."

In A320s, high-pressure air from each engine is ducted to an air-conditioning pack, where the pressure, temperature and humidity are adjusted. The packs are located outside the pressure hull in a compartment that is protected against overpressure by a "blow-out panel." Conditioned air flows from each air-conditioning pack, through a section of flexible ducting/bellows and a non-return valve (NRV) and into the pressure hull.

The report said that the bellows "connects the pack condenser outlet to a rigid duct, which leads to the NRV at [the] entry to the pressure hull." The NRV, which is designed to maintain cabin pressure in the event of a failure of one air-conditioning pack, is a flap held in the closed position by a spring. The flexible bellows is secured by a V-band clamp at its forward end, where a metal rim meets the clamp; at the aft end, the final section of the flexible bellows slides over the condenser outlet duct and is secured by a metal flat-band clamp.

Maintenance records showed that nearly two years before the incident, in July 1998, repairs were performed on the no. 1 pack flexible duct. The notation in the maintenance records did not describe the nature of the repairs but reported that the ducting "appeared to hold OK." Four days later, however, the flexible duct was replaced. In September 1998, the no. 2 air-conditioning pack outflow duct was replaced. Several subsequent notations in the maintenance records involved the no 2 air-conditioning pack, but none mentioned the flexible duct.

The air-conditioning packs had undergone maintenance several times in the days preceding the incident. (Maintenance was conducted by a company under contract with the airline; the report did not name the airline or the maintenance company.) An overheating problem was reported on the no. 2 pack on June 6; a built-in test equipment check and a ground run detected no anomalies. On June 7, the no. 2 pack condenser was replaced because of a cracked flange; the replacement work involved disconnecting and reconnecting the flexible duct at the condenser outlet.

"The engineer who carried out this work while the aircraft was on a three-hour 'turn-round' found that the duct was held on the condenser outlet by a nylon tie-wrap, and he replaced 'like with like,'" the report said. "Though he had some doubts about whether this was the correct attachment method, he became involved with handing over to the next shift after he had completed the job, and he did not pursue the matter or raise a 'deferred defect' to have it replaced or monitored.

"In flight, following the condenser replacement, a low-frequency vibration was reported during the climb, and the no. 2 pack overheated several times in the cruise. After flight, the (nonpressurized) air-conditioning pack compartment overpressure (blow-out) panel was found open. The no. 2 pack was disabled, [and] the exhaust door and its actuator [were] removed due to a structural fault."

Although the no. 2 pack had been disabled by maintenance technicians, during the next three days, the air-conditioning-bay blow-out panel was found open three times. The report said that the blow-out panel may have opened because of "leakage at the no. 2 pack flexible duct, which was pressurizing the bay (perhaps from the cabin), or from other leaking seals in the pack ducting which were later identified."

As a result, maintenance personnel conducted functional checks and leak checks on the no. 2 pack.

On June 9, when the airplane was landed in Manchester, England, the technical log included a report that the no. 1 air-conditioning pack had overheated while the airplane was on the ground in Naples, Italy. After tests showed that the no. 1 pack was serviceable, the maintenance technician installed a new exhaust door and a new actuator on the no. 2 pack.

After the repairs, the airplane was ferried from Manchester to Gatwick. During a descent from FL 190, the flight crew heard "a loud pulsing noise," followed by a 2,000-foot-per-minute increase in cabin altitude. The crew conducted an emergency descent and landed the airplane at Gatwick, where the airplane was reported as unserviceable and the captain wrote in the technical log, "A/c failed to pressurize. All ECAM [electronic caution alert module] ind(ications) (all pages) normal."

The captain later filed a flight safety report containing a more complete description of the rapid depressurization, but the maintenance technician saw only the captain's entry in the technical log. The technician had no opportunity to talk to the crew before performing the repairs.

"The engineer had been working on and [had been] deeply engrossed in an engine defect on another aircraft and was called from that job to investigate and rectify [the problem on the incident airplane]," the report said. "An airline liaison engineer, who had been involved in the work on the other aircraft, accompanied him. While he was working on [the incident airplane], he was interrupted by questions about the other aircraft."

The maintenance technician's inspection revealed that "the no. 2 blow-out panel had deployed and the flexible duct had detached and was in poor condition," the report said.

The technician did not locate the metal flat-band clamp that should have been used to secure the aft end of the flexible duct; instead, a nylon tie-wrap fell out when he removed the access panel to gain access to the duct.

"The size and curvature of the tie-wrap fitted the bellows end," the report said. "[The maintenance technician] found that neither the duct nor the flat-band clamp were available … at Gatwick, and the airline liaison engineer asked whether a temporary repair could be carried out; the airline was having severe scheduling difficulties due to several aircraft having become unserviceable."

The maintenance technician, with help from other maintenance personnel, used fiberglass-reinforced adhesive tape and two tie-wraps to attach the aft end of the flexible duct.

"This produced what appeared to be a much more secure arrangement than that which had previously been in place," the report said. "Such a repair was outside the approval authority of the [maintenance technician], and it should have been considered by the maintenance company's main operations control (maintrol) and an engineering concession [should have been] obtained. Maintrol was contacted by telephone, but the personnel at Gatwick were advised that no one at maintrol would take responsibility for such a repair. Neither did maintrol take any action to prevent the aircraft being returned to operation with this repair. The [maintenance technician] and other personnel at Gatwick were confident in the security of the repair and, after carrying out a functional and leak check, the engineer signed the certificate of release to service in the technical log."

Nevertheless, the leak check, which was conducted using the auxiliary power unit, was not a full-pressurization test and did not subject the duct to full pressure differential.

The report said that the NRV "must have been damaged at this time to allow the loss of cabin pressure when the bellows detached. However, it did not occur to any of the personnel involved, either at Gatwick or maintrol, that detachment of the flexible duct from one pack should not have resulted in a loss of cabin pressure or a failure to pressurize, as described in the technical log. The NRV should have closed off the outflow from the cabin, leaving it pressurized by the no. 1 system. The failure of the NRV was, therefore, not discovered."

After maintenance was completed, the airplane was prepared for the flight to Palma de Mallorca. The captain briefed the cabin crew on the previous problems with the air-conditioning system, including the depressurization during the morning ferrying flight to Gatwick, and the crew altered cabin service procedures to remove as little equipment as possible from galley area and to delay cabin service until the flight crew confirmed that the pressurization system was working properly.

When the passengers boarded, their departure already had been delayed about 15 hours because of technical problems with another airplane, and some passengers "voiced concern over the serviceability of the aircraft," the report said.

The report said that the takeoff from Gatwick was uneventful and that the captain reduced the rate of climb to about 1,000 feet per minute to monitor the pressurization system.

"Initially, all of the pressurization system indications on the flight deck were normal," the report said. "Passing … FL 200, the [captain] selected 'open climb,' which is the normal maximum climb power setting.

"Passing FL 300, the [captain] heard a resonance, similar to that experienced during the previous sector just prior to the loss of cabin pressure. Again, a decompression occurred, and the cabin altitude began to climb rapidly."

The maximum cabin altitude experienced during the event was 14,000 feet.

The airplane's flight data recorder showed that the descent began after the airplane reached 28,600 feet and that the airplane was leveled at FL 280 momentarily before a rapid descent began. At the same time, the cabin-pressure warning activated, indicating that cabin altitude was more than 9,550 feet. The warning continued for seven minutes 30 seconds, until the airplane was flown below 9,000 feet.

A post-incident examination of the airplane revealed that the no. 2 air-conditioning pack blow-out panel was out of place. The flexible duct was disconnected at the aft end, and the detached ends were damaged; the walls of the bellows were chafed and split.

"Its condition indicated that it had been damaged by rapid fluttering and axial compression of its convolutions," the report said. "It was the duct's aft fitting [that] had been the subject of the repair carried out before the flight."

The post-incident examination also revealed that the NRV was damaged. Its flap was broken in half; half was missing, and the half that remained was deformed "in a manner [that] indicated that it had been slammed against the flexible 'open' stop, which normally contacts the center of the circular flap of the valve," the report said. A small piece of the broken valve was found in the under-wing fairing in the bay where the pack is located.

"Its position suggested that the other fragments had also been expelled outward by cabin air through the open end of the duct and had probably been lost through the blow-out panel that had opened in flight," the report said. "This was consistent with bellows detachment preceding failure of the NRV."

The report said that "it seems certain" that the NRV failed during the first depressurization incident on June 10.

"It seems likely that the oscillation of the bellows after it detached on the positioning flight, as well as the competing air flows from the pack and the pressurized cabin, produced severe flow [fluctuations] and pressure fluctuations in the downstream part of the duct to the NRV," the report said. "This resulted in the flap of the [NRV] slamming open and shut, causing it to break. This sequence is consistent with symptoms consisting of a loud noise and vibration as described by the crew."

The report said that the maintenance personnel, during their work on the air-conditioning system the day before the incident, failed to detect the damaged NRV and used an unapproved method of reconnecting the condenser outlet duct.

"This resulted in the duct again becoming disconnected and a subsequent loss of cabin pressurization," the report said. "There were some mitigating circumstances in that the individuals were under considerable pressure to return the aircraft to service and the requisite spares were not available."

The report said that the maintenance company's investigation of the incident had "concluded that there had been significant deviations by staff from laid-down internal procedures and a failure of the engineering management organization to support line staff.

[The internal investigation] also found that the company's reliability-monitoring system had failed to highlight the recurrent problems with the no. 2 air-conditioning pack."

The internal investigation said that the maintenance staff at Gatwick should be briefed "on the limits of their authority and the concession procedure."♦

[FSF editorial note: This article, except where specifically noted, is based on the U.K. Air Accidents Investigation Branch final report on occurrence EW/C2000/6/4.]

Note

1. The report by the U.K. Air Accidents Investigation Branch

(AAIB) said that of the 176 passengers, 53 said that they had shortness of breath, weakness, numbness or tingling sensations. Forty-three said that they had headaches, 13 said that they experienced chest pains and five said that they experienced joint pain. The report said, "Given that the maximum cabin altitude achieved during the incident was 14,000 feet for less than five minutes, the likelihood of anyone suffering the effects of hypoxia (lack of oxygen in the bloodstream) [was] probably limited to those passengers who were heavy smokers, obese or otherwise physically unfit."

In a survey of passengers after the incident, 76 percent of the 106 respondents said that they had difficulty using the oxygen masks and 95 percent of respondents said that they lacked confidence in the operation of the emergency oxygen system. The report said that the absence of an announcement, after deployment of oxygen masks, to remind passengers about how to use them "probably contributed to the difficulties, perceived and real, that the passengers experienced." As a result of the investigation, AAIB recommended the following:

- That the U.K. Civil Aviation Authority should remind operators, if appropriate, that they should include pubic address announcements as part of post-decompression procedures; and,
- That the Joint Aviation Authorities should review requirements for passenger briefings involving the operation of emergency oxygen equipment.

Further Reading from FSF Publications

FSF Editorial Staff. "Cabin-air Contamination Briefly Incapacitates Crew." *Cabin Crew Safety* Volume 37 (January–February 2002).

FSF Editorial Staff. "Flight Crew Incapacitation Follows Learjet 35 Cabin Depressurization." *Accident Prevention* Volume 58 (April 2001).

Mohler, Stanley R. "Quick Response by Pilots Remains Key to Surviving Cabin Decompression." *Human Factors & Aviation Medicine* Volume 47 (January–February 2000).

FSF Editorial Staff. "Racing Balloon Is Shot Down by Air Force Attack Helicopter in Belarus." *Accident Prevention* Volume 53 (July 1996).

Mohler, Stanley R. "A Sudden High-altitude Cabin Decompression Immediately Threatens Safety of Aircraft Crew and Passengers." *Human Factors & Aviation Medicine* Volume 41 (November–December 1994).

FSF Editorial Staff. "U.S. Studies Say Altitude Chamber Training Offers Important Hypoxia Recognition Training at Low Risk." *Human Factors & Aviation Medicine* Volume 39 (November–December 1992).

MAINTENANCE ALERTS

FAA Proposes Inspections of DC-9 Disconnect Panel

The U.S. Federal Aviation Administration (FAA), citing a Nov. 29, 2000, fire in a McDonnell Douglas DC-9-32, has proposed requiring operators of some McDonnell Douglas DC-9 airplanes to inspect a disconnect panel in the left-forward cargo compartment for contamination of electrical connectors by lavatory rinse fluid and for the presence of a drip shield. The inspections of DC-9-10, DC-9-20, DC-9-30, DC-9-40 and DC-9-50 series airplanes would be conducted in accordance with Boeing Alert Service Bulletin (ASB) DC9-24A190 Revision 01, dated Nov. 21, 2001. (The McDonnell Douglas Corp. is now Boeing, Douglas Products Division.)

FAA also said that it would issue a flight standards information bulletin to principal inspectors of DC-9 operators to discuss circumstances of the fire and the importance of proper service and proper draining of lavatory waste tanks and sealing floor panels.

The FAA actions followed recommendations from the U.S. National Transportation Safety Board (NTSB) issued July 9, 2002, during the investigation of an accident involving an AirTran Airways DC-9-32. After departure from Hartsfield Atlanta (Georgia, U.S.) International Airport, the flight crew observed the activation of numerous circuit breakers and illumination of several annunciator panel lights. They declared an emergency and returned to the departure airport for landing.

After the landing, a flight attendant observed smoke at the left sidewall in the forward cabin, and air traffic control observed smoke coming from the airplane. The airplane was evacuated on a taxiway. The airplane was damaged substantially; no one in the airplane was injured seriously.

An investigation revealed fire damage to the left-forward area of the fuselage and the cargo compartment from fuselage station (FS) 237 to FS 313 and damage to the cabin floor.

"Fire damage was concentrated in an area just aft of the electrical disconnect panel located at FS 237, which is a junction panel for seven wire bundles," NTSB said. "The fuselage exterior also exhibited heat discoloration in an area beneath the lavatory service panel located between FS 237 and [FS] 256 and a soot trail that extended aft from the radio rack vent, located just aft of the lavatory service panel. Soot was also present throughout the forward cargo compartment and on the cabin outflow valve near the rear of the airplane."

On sidewall insulation blankets and components near FS 237 in the interior area between the forward cargo compartment and the fuselage, there were blue stains that resembled the color of lavatory rinse fluid. Support brackets were in place above the FS 237 disconnect panel to hold a drip shield, but no drip shield was installed.

Examination of the wires near FS 237 revealed beading — considered consistent with the heat damage caused by arcing — at the ends of many wires. Investigators opened seven electrical connectors and found that one of the connectors had more thermal damage than the others and also contained "light blue and turquoise green crystalline deposits" and "pin-to-pin shorts." Tests revealed elevated levels of sulfate (found in lavatory rinse fluid) in the connector's grommet material.

Examination of another AirTran DC-9 revealed that, although a drip shield was installed, there were dried bluish stains on surfaces near the disconnect panel. Examinations of two DC-9s operated by another carrier revealed that drip shields had not been installed on either airplane and that, although there were no blue stains, "many components were covered with a white, mottled substance, which suggests that a fluid other than lavatory rinse fluid may have leaked from above," NTSB said.

NTSB said that two C-9A airplanes — the military equivalent of DC-9s — were involved in incidents similar to the AirTran accident. Drip shields had been installed in both C-9As; nevertheless, electrical components were damaged by shorting and fluid saturation.

The Boeing DC-9 maintenance manual says that the lavatory waste-disposal system is serviced by draining, washing and flushing the waste tank and filling it with at least 3.5 gallons (13.2 liters) of clean rinse fluid. AirTran's procedure was to use at least 3.5 gallons of rinse fluid but no more than four gallons (15.1 liters).

NTSB said that, when the accident occurred, "neither Boeing's [procedures] nor AirTran's procedures specified how to determine when the tank has been completely drained. Incompletely draining the tank can, over time, lead to an overflow of fluid onto the lavatory floor; the fluid can then migrate beneath the floor and onto components below, especially in areas where the floor panels are not properly sealed."

NTSB said that after the accident, AirTran revised its procedures to "emphasize the importance of completely draining the waste tank," and Boeing issued the ASB and Service Letter DC-9-SL-53-101 discussing the importance of "properly sealing floor panels and adhering to lavatory servicing procedures."

Fatigue Cracks Cited in Metro III Engine Failure

The flight crew of the Fairchild Industries SA227-DC Metro III applied full power for takeoff from an airport in Australia on Aug. 12, 2001, then heard a loud bang. They retarded the throttles and observed an increase in left-engine exhaust gas temperature. They then shut down the left engine. After a passenger observed smoke and flames from the left engine, the flight crew discharged the fire bottle into the left engine, then shut down the right engine and evacuated the airplane.

An inspection of the airplane revealed damage to the left-engine turbine blades and the exhaust nozzle.

The Australian Transport Safety Board said, in a report on the incident, that the failure of the Allied Signal (Garrett) turboprop engine (TPE331-12UHR-701G), was a result of the failure of the turbine first-stage disc-rotating air seal.

The report said that the engine had accumulated 9,140 hours and 3,067 cycles since new. In May 1997, the inner baffle (part no. 3108039-2) was replaced in accordance with Allied Signal service bulletin (SB) TPE331-72-2002, and in July 1999, the compressor interstage seal assembly support was replaced during an engine overhaul, in accordance with SB TPE331-72-2030. After the overhaul, the engine was installed in the incident airplane.

The rotating air seal (part no. 3103839-3) apparently had been in the incident airplane since new. The report said that during the 1999 engine overhaul, the rotating air seal was inspected and was found serviceable. The report said that a cracked rotating air seal was rare on engines that had been maintained in accordance with the two SBs.

Examination of the rotating air seal showed that the entire rim had separated from the flanged section and that 70 percent of the rim circumference had been recovered. Most material from the outer 10 millimeters (0.4 inch) of the plate flange was missing. The report said that in one area with substantial loss of material, there was a "short length of fracture showing evidence of fatigue crack propagation" that had been present before the incident.

The engine manufacturer said that a number of in-flight engine shutdowns had occurred because of separation of the rotating air seal plate rim that followed cracking in the rim. The cracking resulted from elevated rim operating temperatures caused by "hot gas leakage from deteriorated first-stage stator assembly hardware." The two SBs and changes in the engine maintenance manual were intended to address the problem.

"The subject rotating air seal had accumulated over 6,000 hours before the engine had the requirements of the service bulletins incorporated," the report said. "At that time, the seal was inspected in accordance with the current requirements. However, the possibility that the rotating seal failure was related to damage incurred during the seal's prior time in service could not be excluded."

In a separate technical analysis, ATSB said, "Thermal fatigue cracking is a problem associated with repeated differential heating of components and, as such, many turbine engine components are potentially susceptible to premature degradation in this manner. Engine design and operation present the best opportunities for combating thermal fatigue. Appropriate cooling of components is critical to resistance, and design enhancements may be able to be made in this area. Similarly, measures taken to minimize abrupt changes in power settings can also be beneficial in lessening thermally induced stresses within the engine."

Faulty Inspection Cited in Separation of Engine Cowling During Takeoff

During takeoff from Seattle-Tacoma (Washington, U.S.) International Airport on a nonscheduled international cargo flight, the cowlings of the no. 1 engine and no. 2 engine on a Boeing DC-8-63F separated from the airplane. The flight crew returned to the airport for landing. The airplane's left wing and left horizontal stabilizer were damaged substantially; none of the three crewmembers in the airplane was injured.

The U.S. National Transportation Safety Board (NTSB) said, in the final report, that the probable cause of the accident was "inadequate inspection of the no. 1 and [no.] 2 engine cowls by company maintenance personnel and inadequate preflight inspection by the flight engineer."

The aircraft maintenance log showed that maintenance had been performed before the flight to lubricate, inspect and check the four thrust reversers. (After the previous flight, the crew had said that the no. 2 thrust reverser was inoperable; a deferred maintenance item involved a problem with the no. 1 thrust reverser.)

Work on the no. 2 thrust reverser was assigned to a maintenance technician who also was responsible for identifying and correcting a problem with the captain's course deviation indicator (CDI). The technician said that he completed his assigned tasks, then asked the technician working on the no. 1 thrust reverser to "finish up the aircraft and close all engine cowls," the report said.

"He then signed off the no. 2 thrust reverser in the maintenance log and left for the day. (This [maintenance technician] stated that he worked until 1645 on this shift, three hours and 45 minutes past the end of his normal shift.) This [maintenance technician] reported that when he left, all cowlings were wide open and held open by their hold-open rods."

The maintenance technician who was asked to close the cowling doors said that he had lowered the doors but that he and another maintenance technician were unable to secure them. He said that he had written in the turnover log that all four cowling doors required securing and that he also had told two technicians on the next shift. One of the maintenance technicians who received the turnover report said that he had been given the report at 1530, about 30 minutes after he reported to work. He said that the previous day, he had been scheduled to work until 0130 but actually had worked until 0800, then went home and was unable to sleep before returning to work. He said that his primary assignment involved work on a Boeing 747 but that he had worked on the incident airplane about 1630; at the time, the cowlings on the no. 1 engine and no. 2 engine were closed and the cowlings on the no. 3 engine and no. 4 engine were open.

"None of the [maintenance personnel] indicated in their statements that they checked that the no. 1 or [no.] 2 cowlings were latched, although the individual who marshaled the aircraft out on the accident flight indicated that he performed a 'basic walk-around' of the aircraft," the report said.

The flight engineer, who conducted a pre-flight walk-around inspection, said that all cowlings were "verified closed and latched prior to takeoff."

The captain said that the first indication of a problem occurred during takeoff, when the no. 2 engine high-pressure section revolutions-per-minute indication was zero, the no. 2 engine generator light illuminated and the airplane rolled left.

The report said that examinations of the recovered cowling sections revealed that "no cowl sections were attached to each other by any latch mechanisms, and no evidence of distress to any latches, latching pins or associated areas was observed. Of four latches observed on the sections left on the runway, three were observed in the unsecured position and one was observed in the latched position (but not engaged to its mating latch pin; however, a … maintenance representative [said] that the latch found in the latched position had been in the unsecured position when returned, and that the airline's personnel had left it in the latched position in the course of demonstrating/practicing its operation. Both of the two latches observed on one of the sections recovered from [an area near the runway] were observed to be in the unsecured position."

Inspections Recommended for Piper Seneca Nose Undercarriage

The Civil Aviation Authority of New Zealand has recommended that operators and maintainers of Piper PA34-200T Seneca airplanes regularly inspect the nose undercarriage assembly for correct alignment and that they be aware of taxiing and towing limitations.

The August 2002 actions followed a Jan. 25, 2002, accident in which the nose landing gear of a Piper Seneca failed to extend during an attempted landing at Gisborne Aerodrome. The pilot of the emergency medical services flight and a non-flying pilot used normal landing-gear-extension procedures and emergency landing-gear-extension procedures before diverting the flight to Hastings Aerodrome, where the pilot landed the airplane with the landing gear retracted.

The airplane received minor damage, and the two crewmembers and one patient in the airplane were not injured.

The nose undercarriage was steerable and was hinged to retract into the nose wheel well. The pilot's movement of the rudder pedals moved both the airplane's rudder and a "steering channel" that was connected to the nosewheel by a steering tiller and a steering ball. When the pilot retracted the landing gear, the steering ball "slid out of the steering channel and down a track assembly channel," the report said.

An investigation revealed that when the pilot retracted the landing gear on the accident flight, the steering ball moved out of the steering channel and along the outside of the channel, then became lodged there. When the pilot moved the lever to extend the landing gear, the available hydraulic pressure was insufficient to free the ball and extend the nose landing gear. The report said that, if the ball had been freed and the nose landing gear had been extended, the airplane would have had offset nosewheel steering — or perhaps uncontrollable nosewheel steering — after landing.

The New Zealand Transport Accident Investigation Commission said, in the final report on the accident, "The reason for the undercarriage malfunction was not fully determined. However, the nose undercarriage retraction system had become misaligned over time, possibly because of a combination of the nose leg exceeding its limitations during aircraft towing and the aircraft being turned too tightly while maneuvering over rough ground. The misalignment of the undercarriage probably contributed to [its] jamming after retraction."

Inspection of the nose undercarriage assembly was required every 100 flight hours. Nevertheless, the report said that the inspection typically would have given a maintenance technician a side view of the upper portion of the assembly and that misalignment of the assembly would have been difficult to identify.

"A vertical view … would have required the removal of the aircraft's lower panel, which only occurred when specifically required," the report said. "The misalignment could, therefore, have been present for some considerable time."

[A similar accident involving a Piper Seneca at an airport in England resulted in minor damage to the airplane; the flight instructor and student pilot were not injured. Maintenance personnel examined the airplane and determined that, during a tow by a tug, the airplane's steering limits had been exceeded. (See "Tow Damage Prevents Extension of Nose Landing Gear." *Flight Safety Digest* Volume 21 [May–June 2002]: 109–110.)]

Bearing-seal Installation Cited in Nosewheel Failure on EMB-145

An Embraer EMB-145 was being landed in Edinburgh, Scotland, on March 2, 2001, after a flight from Paris, France, when the flight crew heard a "high-speed noise" following touchdown. Because the crew believed that a tire had failed, they stopped the airplane on the runway and asked fire fighters and maintenance personnel to examine the tire. When the crew began to taxi the airplane to allow the maintenance technician to hear the noise, the left nosewheel fell off.

An inspection revealed that the nose-landing-gear axle had broken. The U.K. Air Accidents Investigation Branch said, in a report on the incident, that the area next to the fracture "showed signs of severe 'over-temperature,' with paint in the axle bore blistered and blackened."

The report said, "The evidence clearly indicated that the [nose-landing-gear] axle had failed as a result of severe overheating, which had been generated by bearing [no.] 2 having operated in a grossly deteriorated condition. Local embrittlement and cracking had led to rapid fracturing of the axle, probably under normal loading."

The report said that similar problems involving other EMB-145 airplanes had been caused by dirt and water in the bearings. In this occurrence, however, double seals had been fitted incorrectly at three bearing positions, resulting in "distortion and abnormal wear of the seals and severe degradation of the standard of bearing sealing," the report said.

The report said that causes of incorrect installation were not determined but that "there clearly had been confusion over the different standards of seal deflector configuration that may have been brought about by the fact that 'wheel assembly' part numbers had not been changed to reflect the introduction of the wheel assembly modification."

After the accident, the operator inspected its other EMB-145 airplanes for incorrect installations of wheel bearing seal/deflectors, and found no discrepancies. The operator also issued an alert quality assurance notice and applied decals to EMB-145 nose-landing-gear doors to increase awareness of the different seal/deflector standards described in the *Aircraft Maintenance Manual (AMM)*. Later, the operator required that when nosewheels were replaced, the replacements should have the most recent standard of seal/deflector.

After the accident, the manufacturer issued a field report (no. GST-0773/01) that said that nose-landing-gear bearing inspections should be conducted in accordance with the BF Goodrich *Component Maintenance Manual (CMM)* 32-49-04.

The CMM and the AMM later were revised to include more recent information about part numbers and proper assembly methods.

Overheating of Pitot-static Hose Cited In Flight Deck Fire

The airplane was descending through Flight Level 200 (approximately 20,000 feet) for an approach to an airport in Scotland when the flight crew observed smoke and smelled a burning odor. The captain summoned a flight attendant. When the flight attendant entered the flight deck, she observed flames coming from the wall behind the captain's seat; she used a fire extinguisher to extinguish the flames.

The flight crew declared an emergency and landed the airplane at the destination airport. They stopped the airplane on the runway, shut down the engines and lowered the airstairs. The passengers and crew disembarked, and the airplane was towed to a remote stand.

An investigation revealed extensive overheating damage to a flexible hose connected to a port on the upper-left combined pitot-static probe.

The airplane has four combined pitot-static probes, two on each side of the forward fuselage. The upper-left pitot-static probe is located behind the captain's seat. An internal heater element prevents ice accumulation on the probes. The heater circuit is protected by a five-ampere circuit breaker; during the incident, pitot-static heat was on and the circuit breaker remained retracted.

The investigation revealed that the overheating damage was a result of "internal shorting of the probe heater to the probe body, in combination with degraded bonding between the probe and structure. Corrosion … contributed to this bonding degradation, making flexible hose metallic components the path to ground."

The report said that the corrosion was a result of "the by-products of exterior cleaning of the aircraft, coupled with thermal cycling of the probe, and there was also evidence of internal contaminants, probably due to the corrosion, which had allowed the internal shorting of the heater element to the probe body."

After the incident, the operator inspected combined pitot-static probes on all airplanes in the fleet; no other anomalies were found. The airplane manufacturer also began a review of bonding of the combined pitot-static probes.♦

NEWS & TIPS

Composite Repair Course Offered on Compact Disc, Internet

A self-paced course on the fundamentals of composite repair is available on compact disc or over the Internet, said the manufacturer, Aviation Learning.

The course provides background on composite materials and discusses tools and methods required for work on composites and various types of permanent repairs and temporary repairs. The course can be completed in about six hours and includes a mastery test. A certificate of completion is given to those who complete the course satisfactorily.

For more information: Aviation Learning, One Airport Way, Rochester, NY 14624 U.S. Telephone: (888) 458-5040 (U.S.) or +1 (585) 328-5000 ext. 268.

Cutting Tool Removes Aircraft Seam Sealants

The SR Cutter and the SR Radial Bristle Disc remove seam sealants quickly and safely during aircraft maintenance without damaging underlying materials, said the manufacturer, 3M Aerospace.

SR Cutter

The SR Cutter is a plastic rotary cutting tool that removes thick layers of sealants. It is available in diameters of 0.40 inch (10 millimeters) and 0.83 inch (21 millimeters) and has an integral metal mandrel for use on right-angle drills at low speeds, the manufacturer said. The SR Radial Bristle Disc uses plastic abrasives to remove thin layers of sealants without damaging paint. Both products eliminate the need for harsh chemicals and hand scraping to remove seam sealants, the manufacturer said.

For more information: 3M Aerospace, 3M Center, Building 220-8E-05, St. Paul, MN 55144-1000 U.S. Telephone: (800) 362-3550 (U.S.) or +1 (651) 733-9105.

Oversleeve Protects Cables, Hoses From Heat

The Fyrejacket protective oversleeve combines fiberglass and silicone rubber to protect cable assemblies, hose assemblies, fuel lines and hydraulic lines from heat and flame, said the manufacturer, Federal-Mogul Systems Protection Group.

The oversleeve is made from braided fiberglass substrate and coated with silicone rubber to protect against temperatures up to 500 degrees Fahrenheit (260 degrees Celsius), molten-material splash and welding sparks. The oversleeve expands to accommodate fittings and couplings and is asbestos-free. It complies with the requirements of Society of Automotive Engineers

(SAE) Aerospace Standard AS 1072 Type 2, the manufacturer said.

For more information: Federal-Mogul Systems Protection Group, 241 Welsh Pool Road, Exton, PA 19341 U.S. Telephone: +1 (610) 363-2600.

Fyrejacket Protective Oversleeve

Coating Protects Against Corrosion

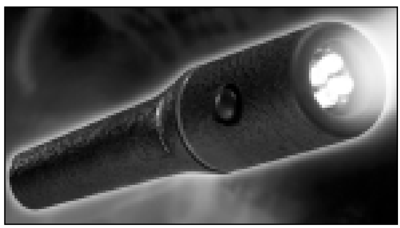
Lumiflon, a durable resin used in exterior paint, protects surfaces — including aircraft exteriors — against corrosion caused by exposure to water, oxygen, ultraviolet light and chemicals, said AGA Chemicals, which markets Lumiflon in the United States for developer Asahi Glass Co. of Japan.

Lumiflon's durability reduces the frequency of repainting and associated maintenance costs, AGA Chemicals said.

For more information: AGA Chemicals, 2201 Water Ridge Parkway, Suite 400, Charlotte, NC 28217 U.S. Telephone: +1 (704) 329-7614.

Flashlight Uses LED Technology

The Lightwave 2100 Portable Lighting System flashlight uses four light-emitting diodes (LEDs), each with a typical life of thousands of hours, said the manufacturer, Lightwave.



Portable Lighting System

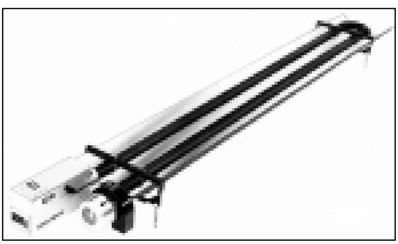
The flashlight has a printed circuit board that controls the flow of voltage from three AA alkaline batteries. This procedure means that the batteries will last 14 times longer than similar batteries powering typical flashlights, the manufacturer said. The flashlight is water-resistant and shockproof, with an industrial grade on-off switch.

For more information: Lightwave, PMB 325, 5665 Highway 9, No. 103, Alpharetta, GA 30004 U.S. Telephone: +1 (678) 393-9072.

Radiant Tube Heaters Provide Even Heating of Large Spaces

Ambi-Rad gas-fired, vacuum-operated ER-series radiant tube heaters provide an even heat distribution for buildings with large open spaces and doors that often are open, said the manufacturer, Advanced Radiant Systems.

The heaters are designed to warm people and objects near the floor rather than the air in the entire space. The heaters have burner ratings that range from 40,000 British thermal units per hour (Btu/h) to 150,000 Btu/h, and are available in U-shaped tubes or straight tubes from 20 feet (six meters) to 60 feet (18 meters) long.



Radiant Tube Heaters

As many as 10 burners can be connected to a single exhaust fan, the manufacturer said.

For more information: Advanced Radiant Systems, 12910 Ford Drive, Fishers, IN 46038 U.S. Telephone: (888) 330-4878 (U.S.) or +1 (317) 577-0337.

Custom-designed Heaters Warm Complex Surfaces

Molded-to-Shape heaters provide efficient, even heat distribution for complex, large surface areas, said the manufacturer, Elmwood Sensors, an Invensys Sensor Systems company.

The heaters are custom designed and then formed, molded or curved to conform around cylindrical surfaces and three-dimensional shapes. They are equipped with single-layer or multi-layer etched circuits or wire-wound circuits and single-watt, multiple-watt and variable-watt densities. They typically are used to prolong battery life in cold environments and in other applications, including aerospace electronics and aircraft galley equipment, the manufacturer said.

For more information: Elmwood Sensors/Invensys Sensor Systems, 500 Narragansett Park Drive, Pawtucket, RI 02861 U.S. Telephone: +1 (401) 727-1300.

Megohmmeter Provides Automated Insulation Measurements

The Model 5060 digital/analog megohmmeter is a fully automated 5,000-volt insulation tester that provides measurements to 10,000 gigaohms, said the manufacturer, AEMC Instruments.

5,000-volt Insulation Tester

The megohmmeter has a software package for display of test results and graphs and a memory function for storage of test results. The megohmmeter can be programmed and controlled by a personal computer, the manufacturer said.

For more information: AEMC Instruments, 200 Foxborough Blvd., Foxborough, MA 02035-2872 U.S. Telephone: +1 (508) 698-2115.

Device Protects Against Static Discharge

The Tow Bar Mounted Grounding Assembly (TBMGA) protects aircraft ground crews and equipment from storm-related static discharge of up to 120 kilovolts, said the manufacturer, Lightning Eliminators and Consultants (LEC). The TBMGA also protects against “bound charge,” which occurs when a storm cell induces an electrical charge on everything beneath the cell — a condition 1,000 times more frequent than a direct lightning strike, the manufacturer said.

The TBMGA comprises stainless-steel components and can be clamped with U-bolts to aircraft tow bars used to move aircraft of all sizes. A spring-loaded plunger presses a stainless-steel castored tire to any driving surface to assure positive ground connection during all phases of ground operation, the manufacturer said. The device eliminates the need for time-consuming procedures to protect against static discharge.

For more information: Lightning Eliminators and Consultants, 6687 Arapahoe Road, Boulder, CO 80303 U.S. Telephone: +1 (303) 447-2828.♦

Call for Nominations

Flight Safety Foundation–Airbus Human Factors in Aviation Safety Award

The Flight Safety Foundation–Airbus Human Factors in Aviation Safety Award was established in 1999 to recognize "outstanding achievement in human factors contributions to aviation safety." The award was instituted to encourage human factors research that would help reduce human error — one of the most common elements in aviation accidents.

The award — instituted by the Foundation and sponsored by Airbus — is presented to an individual, group or organization for a one-time contribution or sustained contributions in the field of human factors. The award includes an elegant engraved wooden plaque.

The nominating deadline is Nov. 29, 2002. The award will be presented in Geneva, Switzerland, at the FSF European Aviation Safety Seminar, March 17–19, 2003.

Flight Safety Foundation

Submit your nomination(s) via our Internet site.
Go to http://www.flightsafety.org/hf_award.html

For more information, contact Kim Granados, membership manager,
by e-mail: granados@flightsafety.org or by telephone: +1 (703) 739-6700, ext. 126.