FLIGHT SAFETY FOUNDATION
Aviation Mechanics Bulletin

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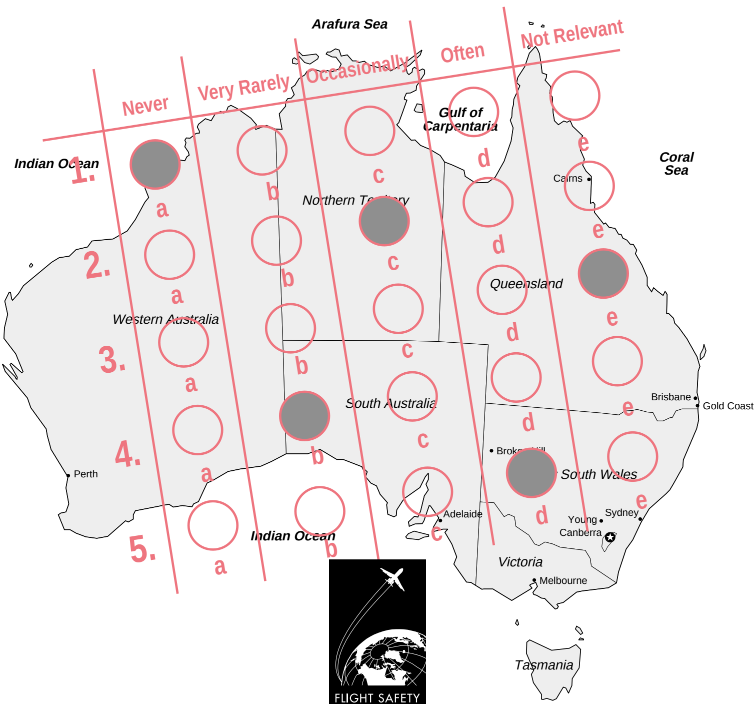

FLIGHT SAFETY FOUNDATION
1947–2000

F L I G H T   S A F E T Y   F O U N D A T I O N

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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Survey Assesses Safety Attitudes of Aviation Maintenance Personnel In Australia

An analysis of responses reveals that the most frequent unsafe acts are procedural shortcuts, misunderstandings and memory lapses.

—

Alan Hobbs and Ann Williamson

Human factors exert a powerful influence on the quality of work and the safety of workplaces. In recent decades, "pilot error" has been the focus of much aviation human factors research. Nevertheless, human factors affect the work of maintenance personnel as well. Worldwide, maintenance deficiencies are estimated to be involved in approximately 12 percent of major aircraft accidents and 50 percent of engine-related flight delays and cancellations.[1]

As an ongoing safety program, the Australian Transport Safety Bureau (ATSB), (formerly the Bureau of Aviation Safety Investigation [BASI]), is investigating the human factors that affect maintenance personnel. In September 1998, BASI distributed a safety survey to licensed aircraft maintenance engineers (LAMEs) and other aircraft maintenance personnel in Australia. The survey was designed to identify safety issues in maintenance, with a particular emphasis on human factors.

This report has been prepared to provide maintenance personnel with factual information on the results of the survey. Analysis of survey results, conclusions and recommendations will be published later.

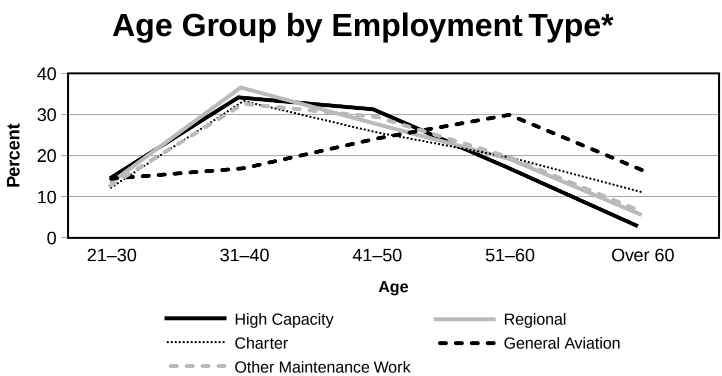
Of the 4,600 surveys distributed, 1,359 were returned, representing a response rate of approximately 29 percent.

Sixty percent of respondents worked on high-capacity airline aircraft, 9 percent worked on regional airline aircraft, 13 percent on charter aircraft, 9 percent on general aviation aircraft, and 3 percent performed "other" maintenance work.[2]

Ninety-four percent of those who responded were LAMEs. The remaining respondents were other maintenance personnel.

Respondents were asked to indicate their age, using 10-year groupings. LAMEs who worked on airline or charter aircraft, or who performed "other" maintenance work, were most commonly in the 31-year–40-year age group (Figure 1). The age distribution for LAMEs working on general aviation aircraft was significantly different. Approximately 30 percent of those LAMEs were in the 51-year–60-year age group, and approximately 70 percent were more than 40 years of age.

Respondents were asked to report the longest period they had been at work in the previous 12 months. The most commonly reported duration was 12 hours, reported by more than 23 percent of respondents (Figure 2, page 3). More than 10 percent of respondents indicated that they had worked for more than a 20-hour period at least once in the previous year.



*Only licensed aircraft maintenance engineers (LAMEs) are included in this figure. In instances in which a LAME reported working on more than one category of aircraft, he or she was assigned to the group represented by the largest aircraft type.

Source: Australian Transport Safety Bureau

Figure 1

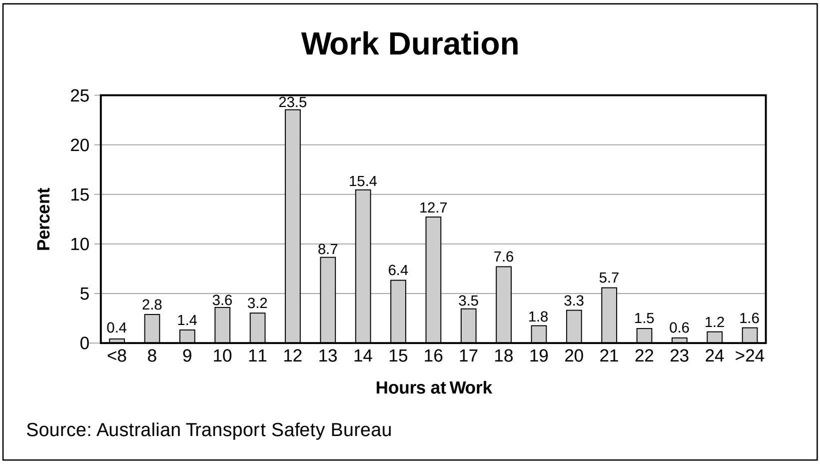


Figure 2

Respondents were asked to report the hours they had worked during their most recent work period (Figure 3). The work attendance pattern reported by those working on high-capacity airline aircraft was significantly different from that reported by workers in other sectors of the

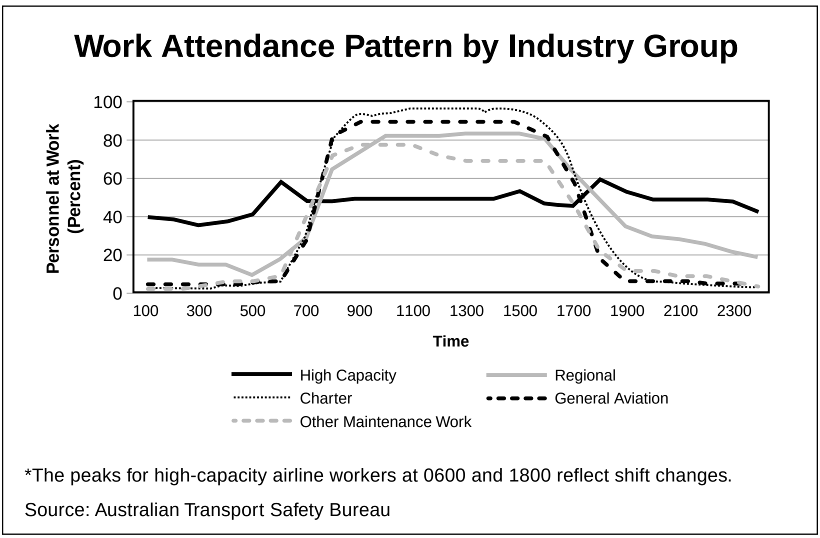


Figure 3

industry. High-capacity maintenance work was being performed continuously throughout the 24-hour day. Those who worked on general aviation and/or charter aircraft, or who performed "other maintenance work," were at work mostly during daylight hours. Workers in the regional airline industry also worked mostly during the day, but reported more night work than those in general aviation.

Six hundred ten respondents used the survey to report a safety occurrence. Occurrence reports were not linked with particular organizations or individuals.

The most common outcomes for airline-related maintenance occurrences were systems operated unsafely during maintenance, towing events and incomplete installations (Table 1). "Systems operated unsafely during maintenance" refers to instances in which aircraft systems such as thrust reversers were activated during maintenance when it was not safe to do so, in some cases because personnel or equipment was not clear of the area.

The most common outcomes of non-airline occurrences were incorrect assembly or orientation, incomplete installation and persons contacting

Table 1
Outcome of Safety Occurrences*

	Airline	Non-airline
System operated unsafely during maintenance	18%	7%
Towing event	9%	3%
Incomplete installation, all parts present	8%	9%
Person contacted hazard	7%	9%
Vehicle or equipment contacted aircraft	7%	1%
Incorrect assembly or orientation	6%	11%
Material left in aircraft	4%	5%
Part damaged during repair	4%	2%
Panel or cap not closed	3%	3%
Incorrect equipment/part installed	3%	4%
Part not installed	3%	6%
Required servicing not performed	3%	4%
Degradation not found	1%	5%
Other	24%	31%

*Figures are rounded to nearest percent

Source: Australian Transport Safety Bureau hazards. (Appendix A shows the definitions of the outcome categories).

More than 95 percent of the occurrences involved the actions of personnel (Table 2). Memory lapses, procedural shortcuts and knowledge-based errors were the most common unsafe acts reported. Some occurrences involved more than one type of action; for example, a memory lapse (such as forgetting to tighten a connection) may have been followed by a procedural shortcut (such as deciding not to perform a functional check due to time constraints).

Respondents were asked to suggest why the occurrence had happened (Table 3, page 6). Pressure, fatigue and coordination problems were the most commonly mentioned factors for airline and non-airline occurrences.

Respondents frequently attributed memory lapses to pressure and/or fatigue. Procedural shortcuts were associated with pressure or a lack of equipment. "Failures to check" frequently involved poor coordination with other workers. "Failures to see" tended to occur when the person was fatigued or when the environment made the task difficult, such as when access was difficult or the light level was low.

The number of occurrences involving the maintenance of high-capacity aircraft varied throughout the day, even though the number of workers present at work did not vary significantly (Figure 4, page 6).

The occurrence times for non-airline related maintenance show two peaks — one at 1000 to 1100 hours and the second about 1600 hours (Figure 5, page 7).

Data for regional airlines are not presented here because there were

Table 2
Unsafe Acts in Occurrences

	Airline	Non-airline
Memory lapse	21%	20%
Procedure shortcut	16%	21%
Knowledge-based error	11%	18%
Trip or fumble	9%	11%
Failure to check	6%	2%
Unintended action	3%	6%
Failure to see	5%	6%

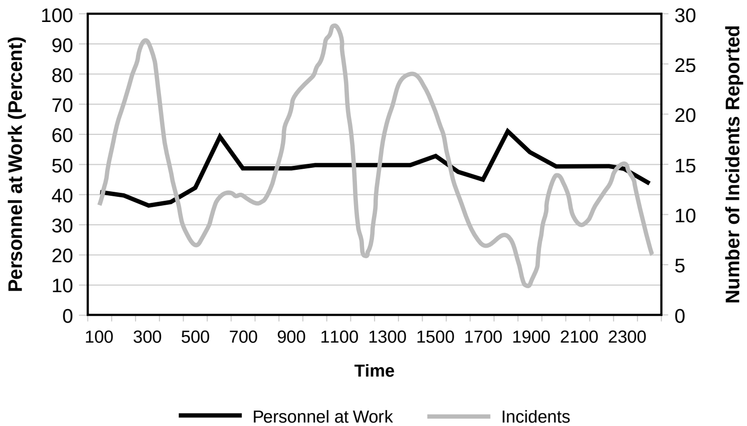
Source: Australian Transport Safety Bureau

Table 3
Occurrence Factors

	Airline	Non-airline
Memory lapse	21%	20%
Pressure	21%	23%
Fatigue	13%	14%
Coordination	10%	11%
Training	10%	16%
Supervision	9%	10%
Lack of equipment	8%	3%
Environment	5%	1%
Poor documentation	5%	4%
Poor procedure	4%	4%

Source: Australian Transport Safety Bureau

Personnel at Work and Occurrences Throughout the Day for High-capacity Airline Maintenance



Source: Australian Transport Safety Bureau

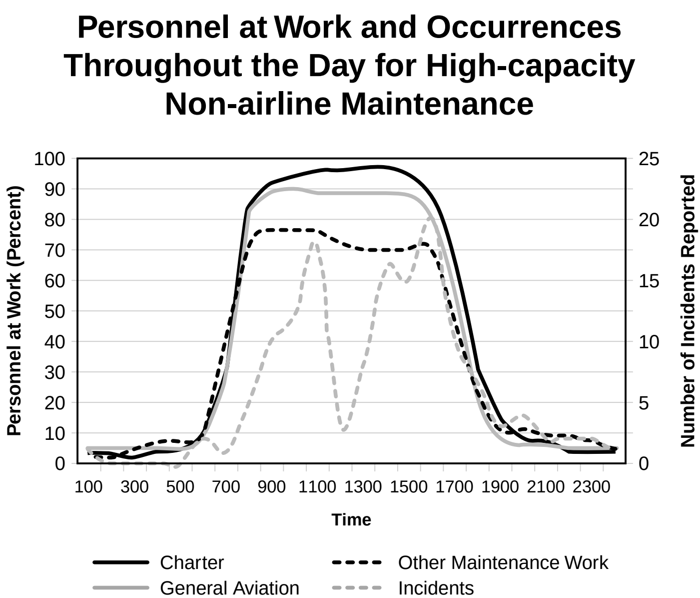
Figure 4

relatively few occurrences for which time information was available.

In addition to the opportunity to describe an occurrence, respondents were also able to indicate whether they had been involved personally in a health and safety or airworthiness occurrence within the previous 12 months.

The majority of respondents reported that they had not been injured at work in the previous 12 months. Nevertheless, slightly more than 30 percent had been injured once, or more than once (Table 4, page 8). Approximately two-thirds of respondents reported that they had been involved in an airworthiness-related occurrence in the previous 12 months.

The questionnaire contained a 48-item checklist of "shortcuts and mistakes" that have contributed to maintenance occurrences in the past. Respondents were asked to indicate on a five-point scale the extent to which they had carried out (or had failed to carry out) each of those actions in the previous 12 months. The scale was designed to gather general judgments rather than specific assessments of frequency.



Source: Australian Transport Safety Bureau

Figure 5

Table 4
Percentage of Respondents Involved in Workplace Injuries and Airworthiness-related Problems During the Previous Year

	None	One	More Than One
Airworthiness-related problems*	32.9%	17.3%	49.8%
Injuries at work**	67.9%	21.7%	10.4%

* Excludes 74 respondents who did not answer this question
** Excludes 25 respondents who did not answer this question

Source: Australian Transport Safety Bureau

The most commonly reported acts involved having "not referred to the maintenance manual or other approved documentation on a familiar job," and having been "misled by confusing documentation." The most infrequent actions were having "accidentally started an engine" and having "added the wrong fluid to a system."

Responses were analyzed using a statistical procedure that identified clusters of related items. Three key clusters emerged: procedural shortcuts, memory lapses and misunderstandings.

Typical procedural shortcuts were having "not referred to the maintenance manual or other approved documentation on an unfamiliar job," or having "turned a blind eye to a minor defect when correcting it would have delayed an aircraft." Memory lapses included having "been interrupted part way through a job and forgotten to return to it," and having "left connections 'finger tight' [instead of torqued to the proper value]." Misunderstandings included having "been misled by confusing documentation" or "because someone gave … wrong information about the stage of progress of a job."

Younger respondents tended to report more shortcuts than older respondents. The reported frequency of memory lapses and misunderstandings, however, did not change significantly with age.

Respondents were asked about their attitude toward procedural shortcuts. Sixty-nine percent believed that it was sometimes necessary to "bend the rules" to get the job done. While 38 percent of respondents believed that their management discouraged shortcuts, the remaining respondents said that management either did not know about shortcuts or tolerated them.

Respondents who said that they had been involved in an airworthiness occurrence during the previous year also tended to report an above-average level of procedural shortcuts. Such respondents however, reported an average level of memory lapses and mistakes.

The respondents who reported that they had been injured at work in the previous year tended to suffer from a slightly greater number of memory lapses but were not more likely to report taking shortcuts or making mistakes.

In summary, the survey found the following:

- Respondents who work in the general aviation industry tended to be older than other survey respondents;
- More than 10 percent of respondents indicated that they had worked for a period of more than 20 hours at least once in the previous 12 months;
- For airline maintenance, the most common forms of occurrences involved systems operated unsafely during maintenance and aircraft-towing events;
- For non-airline maintenance, the most common forms of occurrences were incorrect assembly or orientation of components, incomplete installation, and the contact of workers with hazards;
- Aircraft maintenance personnel are most likely to refer to issues of pressure, fatigue, coordination and training when describing why occurrences happened;
- Memory lapses were the most common form of unsafe act preceding the reported maintenance occurrences;
- Procedural shortcuts were the second-most common form of unsafe act preceding the reported maintenance occurrences;
- Statistical analysis of the unsafe act checklist data suggests that the three main forms of unsafe acts in maintenance are procedural shortcuts, misunderstandings and memory lapses;
- Most respondents said that it was sometimes necessary to "bend the rules" to get the job done;
- Younger LAMEs reported a higher rate of procedural shortcuts than their older colleagues; and,
- The rate of procedural shortcuts is statistically associated with involvement in airworthiness-related occurrences.

Most of the errors reported by the respondents constitute "near misses." By reviewing this information, it is possible to anticipate how more serious events could occur.

ATSB said that the issues identified in the survey are not specific to Australia but will be of use to safety agencies around the world.

Based on early information from the survey, ATSB offered several recommendations:

- Refresher training for aircraft maintenance engineers;
- Removal of barriers that discourage aircraft maintenance engineers from reporting incidents;
- Fatigue management programs;
- Human factors training for management and engineers; and,
- Minimization of the simultaneous disturbance of multiple or parallel systems, such as simultaneous maintenance on both engines of twin-engine aircraft.

The survey is part of a broader study of aircraft maintenance operations, which is expected to lead to identification of more specific safety measures.♦

Notes and References

1. Marx, D.A.; Graeber, R.C. "Human error in aircraft maintenance." In *Aviation Psychology in Practice*, edited by Johnston, N.; McDonald, N.; Fuller, R. Aldershot, England: Avebury Technical, 1994.
2. High-capacity airline aircraft are those with more than 38 passenger seats; regional airline aircraft are those with 38 or fewer passenger seats. Personnel who maintained aircraft from more than one category were assigned to the category characterized by the larger aircraft type.

Appendix A — Definitions of Occurrence Outcomes

Several of these categories are based on The Boeing Company's Maintenance Error Decision Aid system.

System operated unsafely during maintenance: A system, such as flaps or thrust reversers, was activated when it was not safe to do so, either because personnel or equipment were in the vicinity, or the system was not properly prepared for activation.

Towing event: A safety occurrence took place while an aircraft was under tow.

Incomplete installation, all parts present: Although all necessary parts were present, the installation procedure had not been completed. For example, a connection may have been left "finger tight" rather than correctly tightened.

Person contacted hazard: A worker came into contact with a hazard that caused, or had the potential to cause, injury. This category includes electric shocks, falls and exposure to aircraft fluids or other chemicals.

Vehicle or equipment contacted aircraft: A stationary aircraft was contacted by a vehicle or maintenance equipment such as stairs or moveable stands.

Incorrect assembly or orientation: A component was installed or assembled incorrectly.

Material left in aircraft: A maintenance-related item such as a tool was inadvertently left behind by a maintenance worker.

[FSF editorial note: This report is adapted from the Australian Transport Safety Bureau (ATSB) "Aircraft Maintenance Safety Survey — Results," by Alan Hobbs of ATSB and Ann Williamson of the University of New South Wales.]

Further Reading From FSF Publications

Crotty, Bart J. "Improperly Installed Trim Actuators Blamed for Takeoff Accident." *Aviation Mechanics Bulletin* Volume 48 (September–October 2000).

Crotty, Bart J. "Omission of Oil-plug Seals Leads to In-flight Engine Shutdowns." *Aviation Mechanics Bulletin* Volume 47 (July–August 1999).

FSF Editorial Staff; Pinet, Jean; Enders, John H. "Aviation Grapples with Human-factors Accidents." *Flight Safety Digest* Volume 18 (May 1999).

Crotty, Bart J. "F-117A Accident during Air Show Flyover Caused by Omission of Fasteners in Wing-support Structure." *Aviation Mechanics Bulletin* Volume 46 (September–October 1998).

Inspections Ordered for Specific GE CF6-50, CF6-80 Engines

The U.S. Federal Aviation Administration (FAA), citing a Boeing 767's uncontained engine failure during takeoff from São Paolo, Brazil, on June 7, 2000, has issued an airworthiness directive (AD) requiring inspections of General Electric Co. (GE) CF6-45, CF6-50, CF6-80A, CF6-80C2 and CF6-80E1 turbofan engines with specific high-pressure compressor (HPC) stage 3–9 spools.

AD 2000-16-12, which took effect Sept. 5, 2000, requires initial ultrasonic inspections and eddy current inspections of the HPC stage 3–9 spools to detect cracks that can cause a spool to separate and can result in an uncontained engine failure.

The FAA action followed an Aug. 9, 2000, recommendation by the U.S. National Transportation Safety Board (NTSB) that FAA issue an AD to require spool inspections in accordance with a related 1999 AD and engine manual instructions.

The actions were prompted by an incident involving a Varig Brazilian Airlines B-767-241ER equipped with GE CF6-80C2B2 engines. As the airplane reached about 60 knots during its takeoff roll at São Paolo, the flight crew heard a loud bang. They rejected the takeoff, stopped on the runway and evacuated the airplane because of a fire in the no. 2 engine. Airport rescue and fire fighting personnel extinguished the fire. Four of the 191 people in the airplane were injured during the evacuation.

"Examination of the engine revealed that the HPC case had an almost 360-degree rupture between the stage 5 variable stator vanes and the stage 8 compressor bleed air ports," NTSB said. "The stage 6, 7 and 8 disks and a portion of the rim and web of the stage 9 disk had separated from the rest of the HPC stage 3–9 spool and were ejected radially outward from the engine. Approximately 95 percent of the ejected pieces of the HPC stage 3–9 spool were recovered."

The fuselage in front of the right-main landing gear was penetrated, and the underside of the right wing adjacent to the no. 2 engine strut was damaged by heat from the fire. The passenger compartment was not penetrated, and there was no damage to aircraft systems. The fire was caused by fuel that leaked from the fuel inlet line, which was pulled from the fuel pump when the spool ruptured, NTSB said.

Varig records showed that the stage 3–9 spool had accumulated 27,755 hours and 9,948 cycles since new. No defects were found Sept. 22, 1997, when the spool underwent a fluorescent penetrant inspection (FPI) and the disk bores underwent an ultrasonic inspection 8,907 hours and 2,375 cycles before the rupture. The records showed that the FPI was conducted according to GE's recommended practices for deep-disk spools.

A metallurgical examination of the Varig 3–9 spool after the incident revealed "a fracture that originated in the stage 7 web," NTSB said. The metallurgical examination found that the fracture "had broken through the surface and was estimated to be about 0.3 [inch (7.6 millimeters)] to 0.6 inch [15.2 millimeters] long on the stage 7 web surface at the time of the last FPI but had not been detected."

NTSB said that GE fracture-mechanics personnel had said that they were unaware that FPI ever had detected this type of crack (a dwell-time fatigue crack, in which "progressive crack growth occurs during cyclic loading and also over time during sustained peak-stress loading") on the interior surface of an HPC stage 3–9 spool.

"This statement and the circumstances of the Varig Airlines HPC stage 3–9 spool failure suggest that FPI of the interior surfaces of an HPC stage 3–9 spool may be inadequate to detect cracks that are not in the inspector's direct line of sight," NTSB said.

FAA issued AD 99-24-15 in October 1999 in response to the findings of an investigation of a similar uncontained engine failure involving a Canadian Airlines International B-767. NTSB said that it is "concerned that the in-service HPC stage 3–9 spools that have not yet been inspected in accordance with AD 99-24-15 may have undetected cracks that could propagate to critical length and rupture. Such ruptures, if uncontained, could result in a catastrophic accident."

AD 2000-16-12 requires initial ultrasonic inspections and eddy current inspections of stage 3–9 spools with 10,500 or more cycles since new before they accumulate 500 cycles in service after Sept. 5, 2000, by the next engine-shop visit or by May 31, 2001, whichever occurs first. The AD also requires the initial inspection of stage 3–9 spools with 7,000 cycles since new to 10,499 cycles since new before they accumulate 1,000 cycles in service after Sept. 5, 2000, by the next shop visit or by July 29, 2001, whichever occurs first. The initial inspections will qualify the stage 3–9 spools as "previously inspected" for purposes of determining the repetitive inspections schedules under AD 99-24-15 and in accordance with relevant GE alert service bulletins.

Turbine-blade Separation Blamed for BAE 146 Engine Failure

As the BAE SYSTEMS 146 took off from Lyon, France, the flight crew heard a loud noise. Engine indicators showed that the no. 3 engine had failed, and the airplane was landed at Lyon.

The U.K. Air Accidents Investigation Branch (AAIB) said that a series of inspections of the ALF 502-R5 engine revealed that "the fatigue-induced failure of one stage 3 LP [low-pressure] turbine blade had caused secondary failure of three adjacent stage 3 turbine blades, which had then caused secondary failure of all stage 4 LP turbine blades. The resultant LP turbine imbalance had caused the LP shaft to run sufficiently 'bowed' to bring its outer surface into contact with the bore of the HP [high-pressure] shaft, which was rotating at higher speed. The HP shaft had been severely overheated locally by contact with the LP and had separated at this point as a result."

The fatigue probably began as a result of development of larger-than-permitted clearances between the tip platforms of the stage 3 turbine blades — a condition that AAIB said was "known to allow the stage 3 turbine blades to suffer excessive vibration." Once begun, such fatigue probably would have progressed to blade failure "relatively quickly."

The engine had been fitted in the no. 3 position on the airplane in September 1997, after a hot-section inspection at one of the manufacturer's overhaul facilities; the engine had accumulated 13,949 hours and 20,191 cycles since new. There was no record that the stage 3 turbine tip platform clearances were measured during the inspection, as required, and no record of compliance with a manufacturer's service bulletin (SB ALF502R 72-279), which recommended applying a hard-surface coating to contact faces of stage 3 turbine blade tip platforms if wear was beyond prescribed limits.

The service bulletin said that the hard-faced blades "provide greater wear resistance and longer service life for the third-turbine rotor-blade shrouds." AAIB said that the service bulletin did not mention "the potential for such wear to give rise to conditions in which fatigue cracking could develop and result in blade failure, with serious secondary turbine damage, as occurred in this incident."

AAIB said, "The wear of the stage 3 turbine-blade-tip-platform-contact faces to the point where the clearances between adjacent blades became excessive was a consequence of these blades having been returned to service in September 1997 … rather than

… [replaced] with the modified blade type."

Because the service bulletin's recommendation was not implemented, AAIB said, "it would appear that the platform clearances had been assessed to be within the specified limits at overhaul. … However, the platforms of the refitted stage 3 turbine blades appear to have subsequently worn to the point where they became liable to excessive vibration in less than half the overhaul period since that time."

AAIB said, "[A]n explanation of the root reasons behind the introduction of these service bulletins … and a description of the most serious likely outcome resulting from their non-embodiment (serious secondary damage to the turbine) would have given operators a better understanding of the related implications when deciding whether or not to comply with these 'recommended' service bulletins."

Corrosion Found in Inboard Spar Cap Casting

A maintenance technician discovered corrosion on the upper surface of the inboard-spar-cap casting when he removed the right-inboard leading-edge fuel cell on a Beech King Air 300.

The technician said, in a report to the U.S. Federal Aviation Administration, that in five areas, the corrosion had penetrated to as much as 0.15 inch (0.38 centimeter) in depth. Investigation showed that the corrosion was a result of water that had been trapped behind protective tape that was used to line the interior of the fuel-cell bay.

Total time for the part was 8,612 hours.

Engine Oil Seal Suspected as Cause of Cockpit Odors

The flight crew of a Saab SF-340B operating in Australia reported intermittent odors in the cockpit and said that they associated the odors with bleed air from the right engine.

A compressor wash was conducted, and the crew subsequently reported "a strong smell in the cockpit at times during climb, cruise and descent. The smell was accompanied by an oily taste in the mouth with general ill feeling and headaches."

The crew said that their symptoms subsided after they turned off the bleed air from the right engine.

The operator said that there were no further reports of the problem. Nevertheless, the operator suspected that the internal engine oil seal may have been defective, and the engine was to be removed and returned to the manufacturer for further investigation.

Ice in Brake Assembly Causes Airplane to Skid off Runway

The flight crew of a Fairchild Merlin IV (SA-226AT) reported that the left-main landing-gear brake "locked up" during a landing, causing the airplane to skid and then to depart from the runway.

Both left-main tires were damaged from skidding.

A report filed with the U.S. Federal Aviation Administration said that a maintenance technician had reported that water entered the left-brake assembly (BF Goodrich part no. 2-1203-3), froze at altitude and did not thaw before the landing. Because the brake assembly could not be moved, the antiskid system was disabled. There was no explanation of how the water entered the brake assembly.

Faulty Compressor Blade Blamed for Engine Vibration

The flight crew of a Boeing 747 heard a bang from the no. 2 engine during a flight over the Pacific Ocean from Los Angeles, California, U.S., to Auckland, New Zealand, and the cabin crew felt vibrations in the forward galley. The vibration indication for the no. 2 engine increased to four units, on a scale of five, and then stabilized at 2.5 units. Later in the flight, the vibration gradually increased to four units and remained at that level for about 90 minutes. Then, after the aircraft descended to flight level 370 and the thrust was reduced to idle on the no. 2 engine, the vibration decreased to 2.5 units and stayed at that level for the remainder of the flight.

A subsequent visual inspection revealed that a section of the fan-case attrition liner was missing, and a borescope inspection revealed that a stage 1 compressor blade had failed at midspan.

A report by the Australian Transport Safety Bureau said, "This had probably resulted in the increased vibration level. Further investigation revealed that all remaining stage 1 blades exhibited trailing edge tip curling, and several blades had sustained impact damage. Severe damage and heat discoloration of the stage 1 rotor path was also reported."

The investigation did not reveal the source of the damage, but the report said that the damage may have resulted from leading edge blending that was evident on the failed blade, as well as a number of other blades. The blades were returned to the manufacturer for investigation.

The engine was replaced, and the airplane was returned to service.

Structural Crack Found on Elevator Trim-tab Hinge

During a scheduled maintenance inspection, maintenance personnel observed a slight buckling on the elevator trim-tab hinge of a Cessna Conquest.

A report filed with the U.S. Federal Aviation Administration (FAA) said that a maintenance technician removed the upper skin of the elevator adjacent to the trim-tab hinge and discovered "a severe structural crack, which jeopardized the trim tab security." The 12.25-inch (31-centimeter) crack was on the elevator hinge bracket (part no. 5834120-6) between two elevator ribs (part nos. 5834110-90 and 5834110-98). The technician found smaller cracks in the upper radii at the aft end of the elevator ribs and subsequently obtained a repair plan from an FAA designated engineering representative.

Worn Bearings Blamed For Collective-control Anomaly

The pilot of a Sikorsky S-76 reported after a flight that movements of the tail-rotor pedals were driving the collective control.

A maintenance technician found that the tail-rotor quadrant bearings (part no. MKB-16B) were worn and rough. He replaced the bearings, and an operational test showed that the system operated normally. The technician recommended, in a report to the U.S. Federal Aviation Administration, that the tail-rotor quadrant bearings be replaced when tail-rotor cables are replaced.

Fuel Caps Blamed for Retaining Water

The pilot of a Piper PA-30 Twin Comanche reported finding water in fuel samples taken from the airplane's fuel tank sumps.

A report filed with the U.S. Federal Aviation Administration (FAA) said that a maintenance technician's inspection of the airplane revealed that water was dripping from the fuel caps (part no. 27221-00). When the maintenance technician disassembled the fuel caps, he found "a significant amount of moisture inside each cap." He described the fuel caps as older, "thermos-bottle-type" caps and said that they allowed water to leak in through the locking-lever shaft if the bottom metal portion of the cap was distorted or if the attaching hardware had been corroded. He said that the problem became worse if the fuel-filler scupper drains were plugged.

The report filed with the FAA suggested that the fuel-filler caps be checked for corrosion during scheduled inspections.♦

Wheel- and Tire-Handling Pallets Protect Wheels From Damage

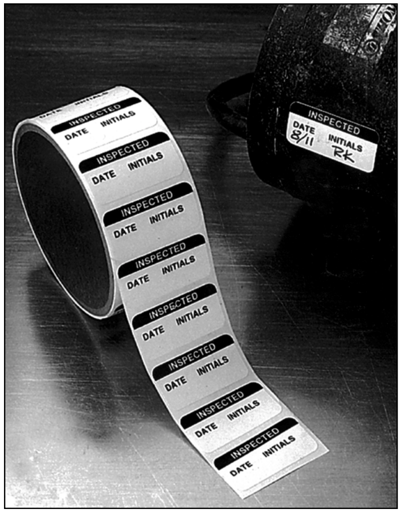
Wheel-handling and tire-handling pallets prevent tire damage from forklift tines and during routine handling, said the manufacturer, Bill Thomas Associates.

The pallets are manufactured from polyethylene in sizes to fit all commercial airline wheel assemblies. Assembly and installation of the pallets require only one minute or two minutes, the manufacturer said. The design of the pallets' base allows for forklift entry from every direction and for vertical stacking.

For more information: Bill Thomas Associates, 7405 Woodley Ave., Van Nuys, CA 91406 U.S. Telephone: +1 (818) 782-2123 and +1 (323) 873-4488.

Special Adhesive Helps Labels Stick to Greasy Surfaces

Calibration Labels for oily/greasy surfaces have an adhesive that helps them stick to greasy surfaces, said the manufacturer, Seton Identification Products.



Seton Calibration Labels

The flexible polyester labels adhere to flat surfaces and curved surfaces, have smudge-proof writing surfaces and are resistant to a range of chemicals. Twenty-one styles are available in three sizes.

For more information: Seton Identification Products, 20 Thompson Road, Brandford, CT 06405 U.S. Telephone: +1 (203) 488-8059.

Seat Track Cleaners Remove Debris

Mounted abrasive wheels can be adjusted to fit inside aircraft seat tracks to remove dirt, gum and other debris

Rex-Cut Seat Track Cleaners

from all surfaces simultaneously, said the manufacturer, Rex-Cut Products.

Rex-Cut Seat Track Cleaners are made of multiple layers of reinforced nonwoven cotton and abrasive grains that have been pressed and bonded to match the inside surfaces of seat tracks. They fit into standard grinders with a 0.25-inch (0.6-centimeter) mandrel and operate by fitting inside an opening and sliding along the track.

For more information: Robert B. Costa, Rex-Cut Products, P.O. Box 2109, Fall River, MA 02722 U.S. Telephone: (800) 225-8182 (U.S.) or +1 (508) 678-1985.

Vacuum Lifters Move Contoured Loads

Powered vacuum lifters with self-adjusting vacuum cup suspensions can lift contoured loads of sheet metal, glass, molded plastic and fiberglass parts, said the manufacturer, Anver Corp.

Anver PF series powered vacuum lifters have rubber suction cups that do not cause the load's surface to pucker or dimple, the manufacturer said. The suspensions have low pivot points located near the load. The lifters can be equipped with beam configurations and cross-arm configurations and are available in air-powered, electric-powered and battery-powered models with capacities from 50 pounds (23 kilograms) to 4,000 pounds (1,814 kilograms).

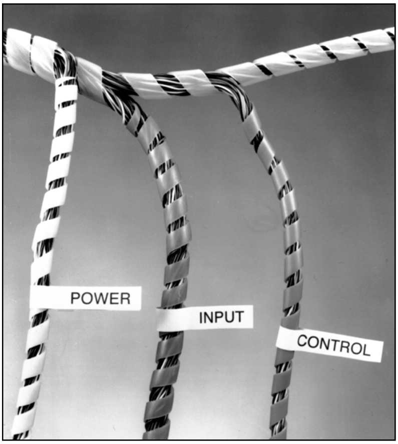
For more information: Frank M. Vernooy, Anver Corp., 36 Parmenter Road, Hudson, MA 01749 U.S. Telephone: (800) 654-3500 (U.S.) or +1 (978) 561-0221.

Head Lamp Designed for Long-term Use

The Lightwave Illuminator Portable Lighting System head lamp (flashlight) uses four light-emitting diodes that typically provide illumination for more than 100,000 hours, the manufacturer said. The head lamp also includes a printed circuit board that controls voltage from three AA alkaline batteries so that the batteries can last up to 14 times longer than in other head torches.

The head lamp is waterproof and shockproof and weighs less than 7 ounces (198 grams).

For more information: Sherry Guimond, Lightwave, 24702 Kim Circle, Laguna Hills, CA 92653 U.S. Telephone: +1 (949) 462-9065.



Heli-Tube Spirally Cut Cable Wrap

Cable Wrap Simplifies Maintenance

Heli-Tube Spirally Cut Cable Wrap is an expandable plastic harness that can be wrapped around wire bundles to simplify maintenance and troubleshooting, said the manufacturer, M.M. Newman Corp.

The cable wrap, available in a variety of colors and in widths ranging from 1/16 inch (1.6 millimeters) to 1 1/4 inches (3.18 centimeters), is designed for color-coding of wire routing.

For more information: Charles F. Loutrel, M.M. Newman Corp., 24 Tioga Way, P.O. Box 615, Marblehead, MA 01945 U.S. Telephone: +1 (781) 631-7100.

Video System Kits Enlarge Borescope Images

The Luxxor 2000 video system can be used with a borescope to enlarge images for a faster and more comfortable inspection of hard-to-reach places, said the manufacturer, Gradient Lens Corp.

The system, which can be used with most borescopes and flexible fiberscopes to make a record of visual inspections, also allows the images to be transmitted on the Internet. The system includes a camera, a video adapter to couple the borescope to any video camera, a light, a light guide and a case.

For more information: Gradient Lens Corp., 207 Tremont St., Rochester, NY 14608 U.S. Telephone: (800) 536-0790 (U.S.) or +1 (716) 235-2620.♦

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