Transport Canada Transports Canada

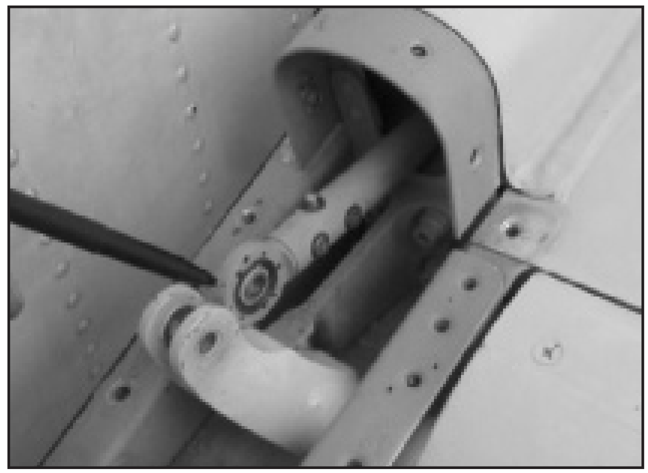
Aviation Safety

Maintainer

Learn from the mistakes of others and avoid making them yourself . . . Issue 3/2004

Critical Maintenance Tasks Requiring an Independent Check

Aircraft maintenance engineers (AME) sometimes wonder about the rules concerning independent checks (dual inspections), even though their application is quite explicit under the *Canadian Aviation Regulations* (CARs) *Standard* 571.10, titled *Maintenance Release*. Subsection 571.10(4) states that, "notwithstanding the requirement to comply with the Performance Rules in accordance with section 571.02 of the CARs, the following additional standards of airworthiness, developed in conformity with section 571.10 of the CARs, apply with respect to the types of work indicated in the [table titled *Types of Work*]." In section *d)* of the table ("Work that disturbs engine or flight controls"), the Standards require that the maintenance release statement confirm that "the system has been inspected for correct assembly, locking and sense of operation, by at least two persons, and the technical record contains the signatures of both persons." In essence, in a commercial operation, two individuals are required to attest that the flight or engine controls on which maintenance was performed conform to the type design. Therefore, they have to be authorized by the approved maintenance organization (AMO), under their approved maintenance control manual. It also means that they are fully knowledgeable of the design, the engineering features and each part of the flight or engine controls under inspection. In addition, the authorization confirms that they have received initial and recurrent training, and are familiar with the latest applicable mandatory service bulletins (SB) and airworthiness directives (AD). Finally, they are authorized under the privileges of the AMO to certify and release the system as airworthy and conforming to type design. Performing a dual inspection is a very serious responsibility, as you will see from this recent tragedy.



McDonnell Douglas DC-8-71F—Test airplane right elevator control tab pushrod contacting the crank fitting.

The DC-8-71F was a fine aircraft, and its crew was very competent. The captain was 43 years old, the first officer was 35, and the flight engineer was 38. They were well respected by the ground crews and they loved their jobs. The aircraft had been loaded with freight and was substantially below its maximum take-off weight (MTOW) at 279 231 lbs; the MTOW was 328 000 lbs. The freight was secured, and the aircraft was refuelled and ready to proceed on its third flight of the day. While cargo handling personnel were loading, the flight engineer was seen conducting a pre-flight inspection of the exterior of the airplane. Although there were minor maintenance discrepancies reported, neither the flight engineer nor the mechanics observed any significant anomalies during the pre-flight inspection. The cockpit voice recorder (CVR) did not record any discussion of airplane discrepancies while on the ground. As some of you know, the DC-8-71F has two elevators that operate in unison through a torque tube and

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McDonnell Douglas DC-8-71F similar to accident aircraft. Photo: Ben Wang, Cupertino,CA, USA (www.airliners.net)

drive rods. Control tabs on the inboard portion of each elevator serve to assist pilot control-column input for elevator travel. Each elevator control tab is hinged to the outboard trailing edge of the associated elevator surface, and then connected by a mechanical linkage (including a crank fitting, pushrod and bellcrank assembly) at the inboard edge of the tab to the flight-control system on that side of the airplane. Geared tabs outboard of the control tabs reduce control force.

As the elevators' positions change in relation to the horizontal stabilizer, linkages move the elevator geared tabs, in the opposite direction, providing an aerodynamic boost to assist the control tabs in moving the elevators. This reduces the amount of force required by the pilots. Dampers are installed in each elevator leading edge at the inboard hinge location and provide an opposing force proportional to the rate of elevator movement to prevent flutter. In compliance with an AD, an elevator position indicator (EPI) was installed in the aircraft cockpit. There is no standard location for the EPI, and in this case, the one-inch diameter gauge was situated on the lower left side of the first officer's instrument panel. The only markings on an EPI are: UP, NEUT (neutral) and DN (down). The AD clearly addressed the issue of the first officer's view of the readings, but not those of the captain flying. The crew conducted the pre-takeoff checklist and made a radio call that they were taking off from Runway 22L and would conduct a left downwind departure.

At 19:49:09, during the take-off roll, the captain said, "watch the tail." The airplane lifted off and entered a left turn. At 19:49:13, the captain said, "V two," then, "positive rate." The airplane reached an 18.3° nose-up pitch at this time and the first officer said, "I got it." The captain said, "you got it." And the first officer said, "yep." "All right," said the captain. A few seconds later the first officer said, "We're going back, the CG [centre of gravity] is way out of limits." By 19:49:22, the airplane's left bank had increased to about 35°. The flight engineer said, "Do you want me to pull back on the power?" No verbal response was given. Seconds later, the CVR recorded a sound similar to decreasing engine speed and a sound similar to a stick shaker indicating a stall. Between 19:49:30 and 19:49:40, the aircraft's left bank decreased to about 13° then it increased to 25°, then decreased again to about 12°. The airplane began to descend from an altitude of 1 037 ft. The flight engineer said, "We're sinking. We're going down guys." The captain told Sacramento departure controller, "We have an emergency…extreme CG problem." There was no further radio contact.

The flight only lasted 120 seconds, but throughout this ordeal the crew rolled, pitched, climbed and descended the aircraft using various flight and engine input necessary to counteract the uncommanded nose-up pitch during the attempted return back to the airport, and away from the city. The crew had conducted an 80-kt elevator check during the take-off roll, as required by the company's procedure manual. It asked that the pilot flying monitor the EPI for response to control column movement while moving the control column full-forward and then releasing it, so that it moves slightly forward of its neutral position. The CVR noted the voice of the Captain saying "80 kt," and the first officer responded, "80 kt…elevator checks." About 12 seconds later, the captain said, "V one" (take-off decision), 4 seconds later, "Rotate." The U.S. National Transportation Safety Board (NTSB) report noted that before rotation speed was attained and control input was added by either pilot, the flight data recorder (FDR) and CVR recorded that the control column had moved aft, and the first officer moved his control column forward to counteract the unusual pitch-up moment of the aircraft. Data indicates that throughout the flight, the crew moved their control column full down, and the nose-down trim full travel but the trailing edge of the elevators never went below the neutral position, preventing the aircraft from recovering from the dangerous nose-high attitude that terminated in a stall.

The way cargo handling personnel conduct their duties can sometimes have a significant effect on the safety of flight, but in this case, the investigation reported that their performance had not been a factor. What the investigation found was that at some time after the previous takeoff and before the accident take-off roll, the bolt, washer and castellated nut that connected the right elevator control tab crank fitting to the pushrod, migrated out of the fitting, allowing the control tab to disengage from its pushrod and shift to a trailing edge down position. The cotter pin that secured the

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Letter to the editor

I wanted to offer some comments on the article, "Pilots vs. Engineers or Us vs. Them: A Question of Safety." (*Maintainer* 1/2004)

I am currently employed with Emirates Airlines in Dubai, United Arab Emirates (UAE), and have been in aviation for 20 years. I am the holder of a current Canadian—aircraft maintenance engineer (AME) licence, UAE General Civil Aviation Authority (GCAA)—AME licence, and American Airframe and Powerplant (A & P) License. I have been an avid reader of *Maintainer* for as long as I can remember.

I was extremely impressed by the frankness of Mr. Pelly's comments, and I am in complete agreement with his sentiment, coming from the "them" perspective of an engineer. His comments are totally accurate; however, I will add that what he has described can in fact be worse in other areas of the industry. I have worked for airlines in Canada and abroad and the situation can be, and often is, worse among airline pilots and engineers. There are several reasons for this; the most predominant being that airline employees tend to be more "experienced," but this does not necessarily mean more mature. With this experience comes ingrained prejudice held about the other profession, based on events throughout a person's career. Another reason is the disparity on fundamental issues such as: working conditions, salaries, maximum working hours, etc. In smaller organizations, the two groups will most likely have less distance between them in these areas, and it is more likely to be a "family" environment by virtue of size. Individuals will get to know each other, conversations will occur and personalities will inevitably clash. One could argue that it is like dealing with your big brother, you either sort it out and get along, or you fight to the death—and in our profession, that is a very real possibility! The fact is that these incongruities will only serve to deepen the rifts between pilots and engineers even further. Each of us feel that we are "worth" more to our organizations than what we are given credit for, and yet we often refuse to willingly communicate with each other on the subjects that are dearest to us. I think that Mr. Pelly stated it perfectly when he wrote, "Communication is the key to developing and maintaining respect." Stated another way, "It is my personal experience that honesty and integrity have served me well over the years. This now permits me to say that I retain the respect of the many pilots with whom I work by strictly adhering to the ethics that bind both our communities—SAFETY FIRST!"

"What we do for each other to make life easier goes a long way to helping relations." Instead, sometimes we use the issue as a way to justify our inaction and frustration at our perceived opponents. Finally, I emphatically agree with Mr. Pelly that we need to instruct and mentor early on this entire issue at AME Symposiums and other similar forums, as they represent an ideal opportunity for a captive audience of engineers with various levels of experience, to open their minds to improving professional relationships.

Kerry Gibson, Dubai, United Arab Emirates

In This Issue

Mechanical Happenings

The following aircraft incidents are a heads-up for aircraft maintenance engineers (AME). They focus on the maintenance outcome of the incident and do not include all of the facts of each incident. In most cases of component failure, it is assumed that a service difficulty report (SDR) was submitted, as it is a Canadian Aviation Regulations *(CARs) requirement.*

Airbus A330—The aircraft was arriving at the gate at London England's Heathrow Airport, when flames were observed near the No. 4 main wheel assembly and brake area. Aircraft rescue and fire fighting (ARFF) services were requested and assisted in extinguishing the fire. There was an indication that all brake units were smoking more than usual after landing. Investigation by maintenance personnel found that the source of the fire was an excess of grease that had migrated out of the No. 4 main wheel bearing assembly and onto the brake unit. The assembly was replaced and the aircraft returned to service.

Beechcraft 100—The aircraft had taken off from Cape Dorset, NU, for a flight to Iqaluit, NU, when, at an altitude of approximately 3 000 ft, the rear cabin door opened. The crew completed the "cabin door unsafe" checklist procedures and was able to return and land safely. The cabin door hydraulic strut and door cables were found badly damaged. The door did not seem to have been secured properly before takeoff. An inspection of the door and locking mechanism revealed that the door handle was not functioning properly, and that the micro switch indicating door security had not been properly adjusted. Maintenance was carried out on the system and the aircraft was returned to service.

Beechcraft 100—The aircraft had departed Thunder Bay, Ont., on a scheduled flight to Fort Hope, Ont. When it was approximately 6 mi. north of Thunder Bay, the crew declared an emergency, advising that they were experiencing smoke in the cockpit and that they would be returning. ARFF services were notified and assumed their standby position. As the aircraft was turning on final, the crew advised that everything was under control and the aircraft landed safely. Company maintenance personnel investigated the incident and found that when power was set at 98% and the dual bleed-air systems were selected and pressurized, a slight musty smell was noted within the aircraft cabin and cockpit area. When the engines were brought to idle, the left wing bleed fail light illuminated. Further inspection revealed that the left-hand bleed air duct had loosened and decoupled between the left engine and the air exchanger. The probable cause was the presence of foreign object damage (FOD) material in an air intake duct. It consisted of a black plastic substance that had been drawn into the ram-air side of the heat exchanger. It had melted onto the front of the air exchanger and was obstructing the passage of air to the heat exchanger. It is believed that blockage of the air exchanger produced a back pressure within the left bleed system, causing the bleed duct to become detached. The blocked air exchanger melted the FOD material, and subsequently loosened the bleed line, which caused smoke in the cockpit during flight. The air exchanger was cleaned, the bleed air duct was secured, and the fire warning advisory system was repaired. The system was successfully tested airworthy and the aircraft was returned to service.

Boeing 737-217—The aircraft was on a scheduled flight from Ottawa, Ont., to Winnipeg, Man. When the aircraft was approximately 15 mi. south of Winnipeg, the crew declared an emergency and requested vectors to the west of the airport to sort out a hydraulic problem. The flight subsequently landed safely and stopped on Runway 36. The aircraft remained on the runway until it could be towed to the apron. Tower temporarily switched from Runway 36 to Runway 31 and no other aircraft were inconvenienced. Company maintenance personnel determined that the aircraft's hydraulic system "A" was depleted as a result of a chaffed hydraulic line in the area above the right main landing gear actuator. The company is submitting an SDR to Transport Canada (TC).

Canadair CL600-2B19—The aircraft took off from Runway 23 at Lester B. Pearson International Airport (LBPIA), in Toronto, Ont. When the aircraft reached rotation speed (V_r) the No. 2 engine began to indicate high vibrations. The takeoff continued and the engine was not shut down. The crew completed the emergency checklist procedures while in the circuit for Runway 23, and declared an emergency. ARFF services were standing by, but the landing was uneventful. A borescope inspection of the engine revealed damage to the compressor and high pressure (HP) turbine blades. Maintenance also found a black scuffmark on the side of the fuselage and on the nosecone of the No. 2 engine. It was determined that the engine had ingested a piece of rubber prior to V_r. The nose landing gear tires on the aircraft were checked and found to be serviceable. The origin of the rubber was not determined.

Line maintenance personnel have a very important responsibility; they are the last airworthiness specialists to review the aircraft status and confirm that the aircraft's main exterior components are fit for flight. In the above case, a probable tire failure was responsible for producing the FOD that caused the engine failure. Could the line maintenance crew have observed the aircraft tire wear and *damage during the last turn-around of that aircraft? It's probable, as line maintenance crews are usually chosen for their advanced knowledge of aircraft systems and their experience in identifying and correcting system deficiencies. FOD causes a lot of revenue loss and creates a great many in-flight emergencies that flight crews have to manage, often under very difficult circumstances. Line maintenance personnel are counted on to be at their best to perform the last safety checks. —Ed.*

Canadair CL600-2B19 Regional Jet—The aircraft was at the gate in Charlotte, North Carolina preparing for a flight to Toronto's LBPIA. The ground crew inadvertently drove away from the aircraft with the ground power unit (GPU) cable still connected to the aircraft electrical ground power receptacle. The failure to check the GPU serviceability before moving it away from the aircraft resulted in extensive damage to the aircraft fuselage and power receptacle. The aircraft was removed from service for repair. *The use of a basic safety checklist before putting the vehicle in gear would have prevented such a mishap and certainly the loss of thousands of dollars by the company. Just as your car insurance automatically goes up with each car accident for which you are responsible, the airline that you work for suffers the same fate each time it solicits the assistance of its insurance underwriter to cover damages caused by the negligence of its own maintenance and support personnel. Think safety, always. —Ed.*

Canadair CL600-2B19 Regional Jet—The aircraft departed Toronto's LBPIA for Dallas/Fort Worth, Texas. Following takeoff, the landing gear was selected and the crew observed a "gear disagree" engine indication and crew alerting system (EICAS) message. The landing gear was extended manually and all three landing gear lights indicated that it was down and locked. The flight landed without further incident and ARFF services were standing by as a precaution. Maintenance investigated the mishap and soon found a nose gear safety pin in position. It is usually installed for safety by the ground crew after landing, when the aircraft has reached the gate.

When these safety pins are first received along with all the aircraft accessories that come with a new aircraft, a red flag is securely affixed to them, to ensure that maintenance and flight crew will see and remove them before flight. After years in service, the red flag disappears and it takes the loss of thousands of dollars in revenue from a cancelled flight before someone will purchase a red ribbon and place it back on the safety pin. We're all part of a team and a team effort is required to keep those complex aircraft flying and our crews and passengers safe. A little effort here and there will pay off in the end. Do your best. —Ed.

Lockheed L382G (C-130 Hercules)—Following a takeoff from Yellowknife, N.W.T., the aircraft experienced a low oil quantity light indication on the No. 2 position, Hamilton Standard propeller. The crew shut down the engine and completed a safe landing. Maintenance personnel did a brief investigation and found that the oil filler cap "o" ring had been displaced during the oil quantity level check and allowed two liters of oil to flow out of the propeller oil sump. The oil was replaced, a new "o" ring was installed, and the aircraft was returned to service.

It is surprising how little attention these oil filler cap and seal assemblies get during inspection, yet they will cause a flight emergency with the accompanying expenditures that never fail to add-up by the end of the year. Lookout for these often forgotten areas; it will pay off in the end. A little Vaseline, DC-4 compound or the recommend lubricant will work wonders and keep those seals performing their duties and your engines and propellers running well. —Ed.

Robinson R44 II—The helicopter was in a slow (40–50 kt) descending right-hand (R/H) turn into wind when it began a 1 cycle per revolution vibration that continued to increase in intensity until the turn was stopped and the speed reduced. After landing, an inspection revealed that one of the blade coning hinges was stiff. The bolt securing the blade was removed with difficulty and put it into a lathe to measure the run-out. The bolt was found to be bent 0.003 in. Most of the bend was at a step, which is worn into the bolt where the head end journal meets the blade spindle bearing. There was also a wear mark in a panel aft and below the mast fairing. This indicated that the mast rocked back at least 0.5 in. There was no evidence of damage to the droop stops or teeter stops. There was no evidence of mast bumping. The Transportation Safety Board of Canada (TSB) and the helicopter manufacturer are investigating and will inspect the bolt.

Schweitzer 269C-1—The transmission had been replaced with an overhauled unit during the last 100-hr inspection, and the pilot had set power to that required for the performance of a tail-rotor balancing and tracking procedure. During this process, the pilot heard a strange noise coming from the aft section of the cabin and he immediately shutdown the engine. As soon as the power was cut-off, the main rotor assembly was ejected from the transmission mast and landed approximately 100 ft away from the helicopter. There were no injuries. The incident is under investigation by the TSB.

Critical Maintenance Tasks Requiring an Independent Check

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castellated nut in place was not found. The aluminium control tab crank fitting and the aft end of the pushrod were intact and exhibited no evidence of internal damage, indicating that the bolt was not in place at impact. By contrast, the aft-end of the left control tab pushrod showed evidence of damage consistent with the bolt having been in place until impact, as it was fractured. The failure of the castellated nut and cotter pin normally affixed to the control tab crank was unlikely and therefore, the bolt must have separated because it was not secured properly nor inspected properly during the airplane's most recent major inspection or subsequent maintenance.

As the airplane accelerated during the take-off roll, the dynamic forces increased and the right elevator control tab crank fitting contacted the disconnected pushrod, restricting that control tab from any trailing edge up movement and positioning it in an extreme trailing edge down deflection. As a result, the elevator surfaces were driven to command an extreme airplane nose-up pitch attitude and the pilots were unable to overcome the effects of the restricted right elevator control tab, despite the large nose-down forces exerted on the control column.

The bolt attaching the right elevator control tab crank fitting to the pushrod had been improperly secured and inspected either during the last "D" type inspection or subsequent maintenance. There were three distinct opportunities to inspect for safety, but everyone failed to recognize the missing cotter pin. The NTSB report recommended, among other things, that the elevator rigging procedures be fully addressed in a separate work card that specifically lists the required inspection items, including verifying the security of elevator control tab attachments after rigging is completed; that all DC-8 work cards related to critical flight controls identify required inspection items as discrete tasks with individual inspection sign-off requirements; that all air carrier operators provide maintenance personnel with more detailed information regarding the steps or actions that are necessary to satisfactorily accomplish a maintenance task; and that the use of outdated, incomplete or otherwise unsuitable reference materials by maintenance personnel during installation and/or assembly of airplane components can occur and is a very potentially unsafe practice.

Before the accident, there had been 6 service difficulty reports (SDR) filed in the previous 5 years regarding fractured crank arms on this specific assembly. However, it seems that this maintenance repair organization's quality assurance department failed to follow-up on this and print the required work cards to ensure that the crank arms were sound and airworthy at the same time that the torque tube assembly was secured. We will never know the reason why this organization dispensed with a tool that might have saved the crew and the aircraft. The SDR databank has been structured in a way to make critical airworthiness information regarding aircraft systems and assembly easily accessible. The information is obtained from organizations such as yours and from AMEs who are concerned about the continuing airworthiness of aircraft. In turn, this information reduces the risk that such mishaps will occur. So the next time you set out to work on or inspect an aircraft, why not review all pertinent SDRs and write up the work cards to take into account those specific additional inspection items that may be critical to safety. In the accident above, it is highly probable that if the maintenance crew had been aware of such SDRs, they would have paid more attention to the airworthiness of the assembly and the flight crew would have lived to carry out many more flights. The requirement of a dual inspection of flight or engine controls should not be taken lightly, as illustrated by this tragedy. Always give it your best, and take advantage of all the tools at your disposal.

Conferences and Meetings

- The Canadian Aviation Maintenance Council (CAMC) will hold its Annual General Meeting and Forum from September 29 to October 1, 2004, at the Delta Victoria Hotel in Victoria, B.C. The theme of this year's Forum is "Leadership + Innovation." For more information, http://www.camc.ca

  Some of the topics that will be discussed are: Leadership & Best Practices; Innovation and the Boeing 7E7 Aircraft; Challenges through Consolidation: Maintenance & Manufacturing Amalgamation; Innovation & the Future of Air Transportation; Innovation in Training: A New Model for the 21st Century; Workplace Essentials: Communication, Teamwork & Awareness.
- The Pacific AME Association (PAMEA) is sponsoring a Human Factor in Aviation Maintenance Course presented by Gordon Dupont. It will be given at Alpine Aerotech Ltd., 1260 Industrial Rd., Kelowna, B.C., on October 23 and 24, 2004. The event is tax deductible as educational and professional training.

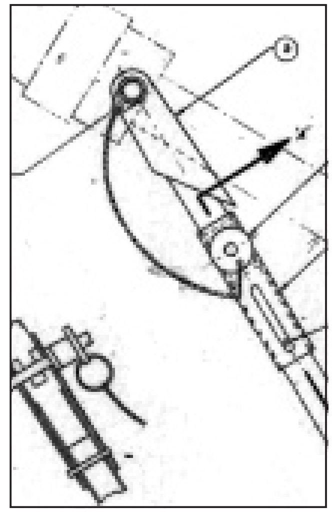
  Contact: Dave Millar at 250 769-4111 (dmillar@alpinehelicopters.com) or John Latta, 250 656-5433 (john@lattaaviation.com) or PAMEA at 604 279-9579 (pamea@telus.net).

  Note: This course will lead into the Bell Helicopter Maintenance Conference on October 25 and 26, 2004, also being held in Kelowna, B.C.

Sikorsky S-61 Helicopter: Frozen Collective Friction Lock Can Be A Serious Hazard

The Canadian-registered helicopter was flying to a mobile offshore drilling unit (MODU) off the coast of Newfoundland when the crew experienced a frozen collective lever while on approach to land. It was to be a crew-change flight, and there were ten passengers and two crew members on board. During the final approach, the pilot attempted to apply collective up, but it was stuck in its cruising flight position. The pilot immediately advised the non-flying pilot of his predicament and asked for assistance to try and move the collective, but to no avail. The decision had to be made whether to land on the offshore rig or to overshoot and return to base. The crew decided to proceed with the landing, and with judicious use of power by the non-flying pilot and control handling of the cyclic by the pilot flying, an uneventful landing was made.

Frozen collective control is not a typical occurrence, but over the years, it has occurred on many different types of helicopters. Adjustment of the S61 collective friction lock seems to be a straightforward matter when you read the maintenance manual, but there have been several occurrences of friction lock failure over the years. Proper control of the collective at all times constitutes a critical element of flight for the pilot. In view of recent problems with the collective friction lock assembly, Sikorsky Aircraft revised the S-61 maintenance manual section 65-42-1 on May 13, 2003, to include a temporary revision No.65-100 on the subject of collective control stick friction lock. It warns that, "Over adjustment will cause excessive friction, preventing proper operations of flight controls. Correct assembly of friction lock components and safety is critical to ensure safety of flight: check to make sure the knurled fitting can be rotated several turns in the decrease friction direction." The friction lock glides along the tube of the collective stick, and contact with a belt buckle or a hard object may damage the tube. When this occurs, the friction lock mechanism will bind and prevent proper operation of the collective control. Inspection of the tube for nicks and burrs, and maintaining the system to specifications will ensure that the collective will perform its intended function every time.



A North Sea operator has adopted a safety modification that allows for the quick disengagement of the collective friction lock assembly. It is a "ball-lock pin" assembly that releases the friction block sufficiently to allow free movement of the collective. The quick-release mechanism is placed on the drag strut where it effects a mechanical disconnect between the links, allowing for a freedom of play. It may be appropriate to adopt such a modification, as it might assist a pilot to a safe landing if a failure of the friction lock occurs during an emergency situation. The modification in Canada was approved under a limited supplemental type certificate issued to Canadian Helicopters of Richmond B.C.; LSTC P-LSH98-197/D. Full collective control is critical to safe flight. Use the utmost care when adjusting and performing maintenance on this assembly.

Colour Me Orange—Fluorescent-orange, That Is!

While doing a maintenance check on a Bell 206B, a young technician found a roll of lockwire forgotten in the drive-shaft area. It was probably left there inadvertently during the last drive shaft disk pack coupling torque check or replacement. Nothing happened this time and the operator was fortunate that none of the stainless-steel wire came loose or got caught on a coupling's lockwired fastener, as the shaft could have been sheared if entangled by the wire. Such a mishap occurring in flight could have led to a loss of control, and possibly casualties. The initiatives taken by this management team were commendable; a safety review meeting was called soon after the incident, and several areas of concern were identified. Through everyone's action, changes were made to reduce the more hazardous situations that were identified. Items such as tool management, training and consumables were reviewed, and a recommendation was made that lockwire-suppliers should fabricate the roll itself out of a fluorescent-orange plastic. This would go a long way in reducing the possibility of such an item being forgotten in a dark corner of an airplane because fluorescent-orange is very different from all other colours, and leaves an imprint in our memory. It would surely ease detection. Thanks go to the maintenance team of this organization for submitting such an idea, and thank you "G.C." for forwarding this information. Remember that in the quest to lower the risk of mishaps, every little bit counts. Each flight that is postponed or cancelled due to foreign object damage (FOD) costs plenty to you, the employee, and to your company. Please participate in all safety initiatives, as it is a guarantee for success.

Again, my thanks go to this maintenance team, who has painted their rolls of lockwire fluorescent-orange. If you have ideas on ways to improve safety, it will be our pleasure to pass along this information through our publication, the *Maintainer*. Safety is a team effort and it should be everyone's game. Your first order of the day is, "think safety." You will be doing yourself, and everybody else, a favour.

Fatigue and Performance

by Jacqueline Booth-Bourdeau, Chief, Technical and National Programs, Aircraft Maintenance and Manufacturing, Transport Canada, Civil Aviation

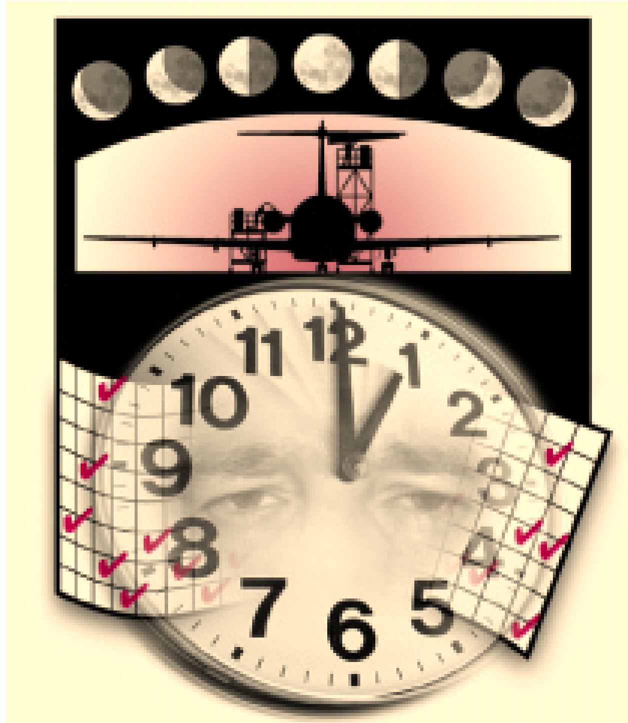
One of the most insidious aspects of fatigue is the inability of the sufferer to recognize deteriorating performance.

When we talk about fatigue in aviation, we usually think of pilots. We know that fatigue-induced human performance errors are a causal factor in many operational incidents and accidents. This realization has lead to a profusion of research and regulatory activity in the form of duty time regulation. The pilot fatigue equation is easy to grasp. Pilots face operational demands that can include trans-meridian travel, night work, shift work and irregular work schedules. We tend to focus on the pilot issue because of the immediate consequences of a fatigue-induced error. It's a simple formula; pilot falls asleep, aircraft crashes.

From the maintenance perspective, it's not quite as clear cut. The connection between fatigue and maintenance error is not as well defined, nor as well documented. This is in spite of the fact that physiological challenges are still the same: shift work, night work and long working periods. The link between fatigue performance-impairment is somehow perceived as less critical because the maintainer is not seen as being on the front line. The fact remains, however, that many maintenance tasks are performed in the middle of the night when the propensity for human performance error is at its greatest. This assertion is borne out by a growing body of evidence documenting performance degradation at the circadian low point: the middle of the night.

Fatigue-related performance degradation is not just isolated to shift work and night work; it is also associated with long shift durations and the number of consecutive days worked. Professor Drew Dawson at the University of South Australia has equated fatigue-related impairment to alcohol impairment. His research has shown that after 17 hours of wakefulness, fatigue-related impairment is equivalent to a blood alcohol level of 0.05 percent. After 24 hours of wakefulness, this increases to 0.10 percent—well over the legally prescribed limit for operating a motor vehicle.

Perhaps one of the most insidious aspects of fatigue is the individual's inability to recognize when their own performance is deteriorating, and to take appropriate actions. Of course, in the 24-hour-a-day aviation industry, it's usually impossible to quit work when you are feeling tired. The economic considerations of the aviation industry demand that maintenance be completed in an expeditious manner, which often means continuing to work until the job is done. There may also be



good safety reasons for the occasional extension of working hours. For example, it may sometimes be necessary to weigh the possible effects of fatigue against the potential for miscommunication in handing over a partially completed job to another person.

So, what are the options? From the perspective of the individual, there are measures that can be taken to manage fatigue. This might be as simple as improving your awareness of the symptoms of fatigue, or as complex as a night shift adaptation program. Fatigue management, however, is a shared responsibility between the employee and the employer. In effect, the employer should ensure that all work-related causes of fatigue are effectively managed, and the employee should ensure that all non-work-related causes of fatigue are minimized.

From the government perspective, the issue of fatigue management is not likely to be as simple as dictating duty time through regulation. After all, while duty time regulations do limit hours of work, it is impossible to regulate the hours that one sleeps. It is a common misconception that time off means restorative rest. Only sleep will restore alertness and only the individual can ensure that they get sufficient sleep. The responsibility is yours—take action against sleep deprivation and opt for a stable restorative rest period between shifts and family obligations. The short- and long-term benefits will reward you with a productive and fulfilling life.