Transport Canada Transports Canada

Aviation Safety

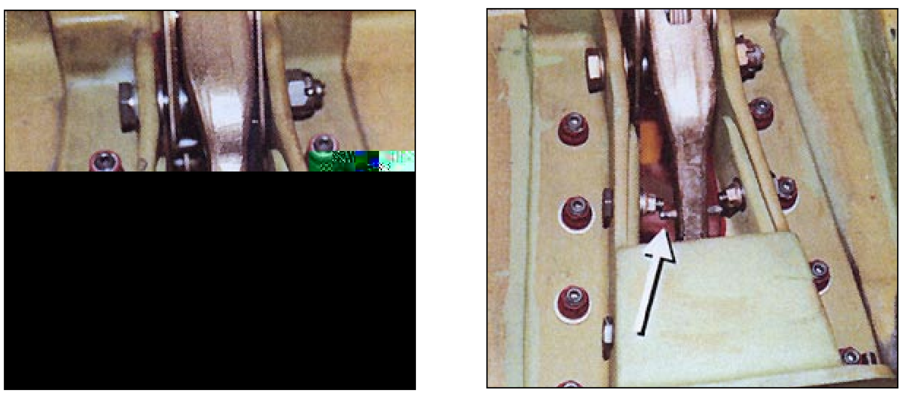
Maintainer

Learn from the mistakes of others and avoid making them yourself . . . **Issue 4/2000**

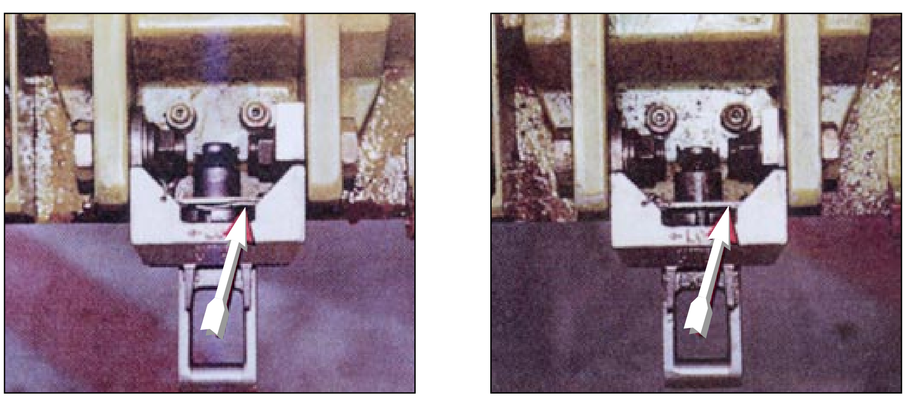
Large Aircraft Cowl Fastener Problems

Historically, fan cowls and engine cowls have occasionally departed aircraft in flight and, in the case of wide-bodied Airbus and Boeing series, about seven to nine times per year. For the Airbus, research has established that there are over a half dozen previous cases of fan cowl door loss from A300, A319, A320 or A321 aircraft for a number of reasons, including improperly engaged or unserviceable latches. In the case of large jet aircraft, installation of the cowls is usually a two-person operation using correct tools and stands. If one person attempts the job, there is that much greater risk of it being done incorrectly. In summary, if the manufacturer's installation instructions are carefully followed, the installation should not fail. On the other hand, if the design or assembly of the latch is proven to be the cause, then improperly installed bolts or other problems should be corrected.

In Maintainer 3/2000 I dealt with a number of issues generic to the underlying cause associated with most cowl losses in flight. In this issue the following photos are specific to an Airbus A330 cowling that departed the aircraft during flight. They are assembled below to illustrate the areas to be alert for that may help lower the risk of recurrence in the case of Airbus wide-bodied aircraft.—Ed.



Latch subassemblies with bolts installed in opposite orientations.



Normal and failed star-adjustment retention springs.

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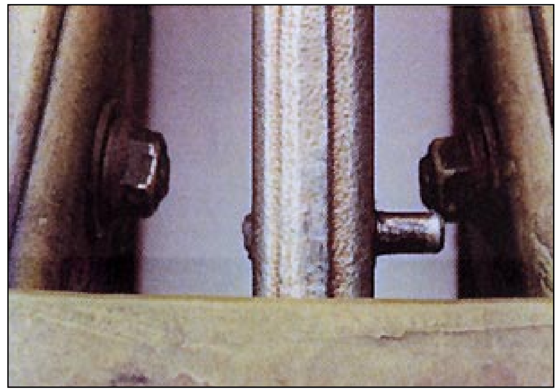
Incomplete trigger/safety engagement on A320 engine fan cowl.



Damaged latch subassembly from the occurrence aircraft.

Occurrences continue to happen, as evidenced by the most recent case on September 13, 2000, when an Airbus A320 lost an engine cowl during takeoff, requiring an immediate return to the airport after declaring a problem maintaining altitude. The cowl was subsequently located on the airport runway.

In the case of the Airbus incidents, the appreciable number of previous cases should have been sufficient to have prompted the introduction of effective measures to prevent recurrence prior to the most recent accidents. The powerplant manufacturer of the V2500 engine had developed a number of measures, of which some were categorized as recommended and were considered unlikely to be sufficiently effective. The measure most likely to be effective, the installation of a hold-open device (SB 0259), was categorized as a customer option. It appears that Airbus Industrie should assess the adequacy of their process for determining the possible adverse flight safety implications of reported incidents and accidents involving their aircraft and for advising operators of effective measures to prevent recurrence. Finally, all aircraft can be subject to this problem because of the frequency of removal and installation of cowlings for maintenance, and large aircraft of the Airbus series, Boeing series, and the McDonnell Douglas MD-11 are particularly vulnerable, as the incidents verify.

Possibly Preventable Incidents

The crew of a **Bombardier Global Express** aircraft, during the first production test flight, found that both elevators were jammed. The crew landed safely after declaring an emergency, but found the elevator travel was limited to one to two degrees in either direction. They also found the stabilator trim did not provide the amount of travel required for landing, so they used a combination of thrust and pitch trim to maintain control of the aircraft. At some point prior to landing, the crew managed to break the right-hand elevator loose, allowing the aircraft to touch down at a higher-than-normal speed (approximately 140 kt) without further incident.

A company maintenance investigation observed by a TC inspector revealed that an unflagged rigging pin, which is routinely only partially removed during elevator rigging (because it is very difficult to insert into the quadrant hole again), was never removed from the quadrant under the flight compartment floor before flight. During the pilots' combined efforts to break the jammed elevators loose, the end of the pin was sheared off, allowing control of the right-hand elevator. It is believed that this pin vibrated into the elevator control mechanism during flight, preventing normal elevator travel. The reason the elevator disconnect did not function when selected is still under investigation by the company. All aircraft in flight status at the facilities were grounded pending further inspection of these aircraft for full flight control travel and the removal of all rigging pins.

The student pilot of the **Cessna C-150** was returning to the airport after a solo flight when he experienced a loss of engine power as the engine abruptly began to shudder and cough. The propeller continued to rotate, but not enough to provide propulsion. The student managed to land safely at the airport. Company maintenance reported that the rear section of the engine exhaust muffler was cracked, leaving a hole for the hot exhaust gases to escape into the engine compartment directly onto the firewall. The intense heat melted the magneto "P" lead wires running along the firewall, grounding out the magnetos. The muffler had been inspected as required by Airworthiness Directive (AD) CF90-13R2 (inspection of muffler shroud used for cabin heat). The muffler's total time since new (TTSN) was 4622.5 hr.

The pilot of a **Hawker Siddeley DH-125-3A/RA** business jet was advised by the control tower that the right main landing gear had not retracted after takeoff. The pilot confirmed that he had a red light indication, recycled

cont. on p. 7

Transport Canada / Transports Canada

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Sécurité aérienne — Mainteneur est la version française de cette publication.

To The Editor

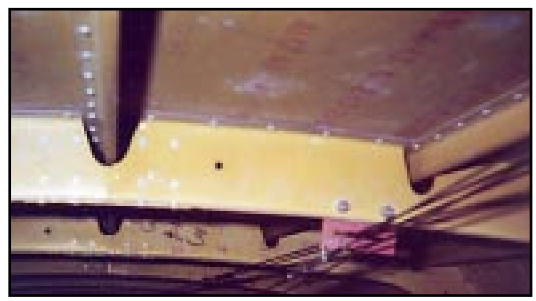
Mr. Mel Goddard wrote about the tension and torque problems raised in issue 3/00 of the Maintainer in the article entitled "Insufficient Clamping Force." A brief synopsis of his letter follows.

I disagree with loss of torque as it was presented in the Maintainer article; the failure was the result of the loss of tension on the fastener assembly, not torque. Torque is a roundabout way of achieving the necessary tension of the fastener to hold two or more pieces of something together. The tension of the bolt was less than the working load, and the photo accompanying the article illustrates the classic beach mark of a fatigue break.

There could be other reasons for the loss of tension: Was the torque applied to a dry fastener or was it wet? Was the proper washer used (if required)? Were the nuts re-used several times? Was there a material hardness deficiency in the cylinder base? All of these factors can apply; this is not to suggest the investigation was flawed, it is to provide added possibilities to the Maintainer article.

Finally, proper fastener hardware that is correctly assembled and tightened will never lose tension and fail. I question the point on retorquing from time to time; what is causing the nuts to lose their tension? Is their support base collapsing? Advising to carry out non-destructive testing on any doubtful fasteners is a good plan, but I would not stop there. I would look for other possibilities as stated.

Peter Verbree, a TC civil aviation safety inspector for aircraft maintenance, writes about a trim control problem he found on a DHC-2 de Havilland Beaver aircraft. The letter has been edited, but here is the story:



The above photo illustrates the area where the pigtail was catching on the fairlead during operation of the trim control.

As I sat in the cockpit, checking the function of the elevator trim controls of a de Havilland DHC-2 Beaver, the trim wheel suddenly felt stiff. When the wheel was actuated in the reverse direction, something broke free with a resounding "thud." Upon further investigation I discovered that an incorrectly lockwired turnbuckle was hooking on an adjacent fairlead in the area above the baggage compartment. Since the area is rather hard to access, it appeared that the person locking the turnbuckle looked at the easiest method and used wire twisters to lock the turnbuckle, leaving a large "pigtail" sticking out to interfere with the operation of the trim control as it passed through the fairlead. Further research revealed that Advisory Circular (AC) 43-13-1b illustrates five methods of safetying turnbuckles, none of which use twisted wire pigtails. The moral of the story is to refer to the manufacturer's recommendations or equivalent. If no specification is made, use standard industry practice and reference material, such as AC 43-13-1b, the reference that would have required a different procedure from the incorrect one used in this case.

Mechanical Happenings

The following aircraft incidents reported to TC from June 1, 2000, to Sept. 1, 2000, are a heads-up for AMEs; they mainly focus on the maintenance outcome of the incident and do not include all the circumstances of each flight. In most cases of component failures it can be assumed that an SDR was submitted. Again, there were numerous false warnings affecting various aircraft types caused by undercarriage, fire, engine, hydraulic and cabin warning systems failures, which suggests more careful maintenance of warning systems is needed in general.

Aero Commander 100—The pilot carried out a successful forced landing in a field as a result of oil pressure loss. Maintenance found that a copper oil pressure sending line broke off at the engine fitting, allowing the engine to lose all its oil.

Airbus A320-211—The crew observed that the No. 2 engine oil quantity indicator had dropped from 17 qt. to 3 qt. All other engine parameters were normal. Company maintenance discovered and replaced a faulty oil quantity indicator.

Airbus A340-313—The pilot landed en route because of a yellow hydraulic system low quantity indication. Maintenance identified and replaced a leaking seal on an associated system's module check valve and returned the aircraft to service.

Air Tractor AT-401—The pilot had just started his spray run when the engine began to vibrate violently; he landed immediately. An examination of the aircraft determined that 12 in. of one propeller blade had departed. A possible contributing factor, according to the pilot, was that he had encountered a bird strike while spraying the same field before the blade separation.

Beech A100 King Air—After an overheat report, maintenance identified a fault in the left-hand bleed air warning system. The EVA tubing became disconnected at the supply manifold located under the centre section of the cabin floor, causing the system warning light to illuminate. Maintenance trimmed the end of the EVA tubing and resecured it.

Beech A100 King Air—The pilot returned to the airport because of a loss of oil pressure on the left engine. Maintenance found an oil leak in the vicinity of a loose oil filler cap.

Beech 1900C—The pilot returned with an engine out. Maintenance found a leak in the P3 air line (P/N 3032125) caused engine to decelerate to idle and the propeller to autofeather. The stainless steel line had broken at a bend in the line. The line was replaced with a new part, which subsequently failed in the same area eight hours later. This occurred while aircraft was on the ground. Both lines have been sent to the engine manufacturer (Pratt & Whitney) for analysis. The engine is a rental unit, and the line is a part that comes with the engine, installed at overhaul.

Boeing 737-2T2C—The crew experienced a significant nose wheel vibration during takeoff. A maintenance examination of parts discovered on the runway revealed that the retainer had disengaged from the nose ski and that a large strip of rubber was missing from the outboard side of the left nose wheel.

Boeing 767-233—The crew noticed the engine surge and, after a loud bang, the engine power decreased to idle. Maintenance replaced the fuel control unit (FCU), the engine vane and bleed control (EVBC) and the TT2 sensor. An uneventful engine ground run and flight test were performed before the aircraft was returned to service. The replaced parts were sent for further investigation.

Boeing B747—The aircraft was landed en route because of trailing vapour. Maintenance found that the high-pressure fuel line used for actuation of the movable engine stators was broken. After an additional crack was discovered in the fuel line, it was decided to carry out a three-engine ferry flight to a maintenance facility.

British Aerospace BAE 146 Series 200—The pilot reported a hydraulic problem when the aircraft's yellow hydraulic system low pressure light illuminated. A short time later, the hydraulic system lost 75% of its pressure. Maintenance found that a hydraulic system fitting (P/N MS21902W6) had cracked and failed in the threaded area, allowing the fluid to be lost.

Canadair CL215 1A10—The crew reported "engine problems", but the flight landed safely. Company maintenance found that the No. 13 cylinder had failed and replaced it.

Canadair CL-600-2B19—The crew reported an oil pressure and temperature problem. Maintenance found two scavenge filters clogged with carbon residue. The carbon seals had been replaced a few days before this flight. The filters were cleaned, the carbon seals replaced, and the engine ground run successfully.

Cessna 180K—The pilot made a wheels-up landing on the floats as a result of indication problems. An engineer has advised that a new hydraulic pump was required as the breaker had popped before the wheels became full down and locked. Also, the pilot failed to check the mirrors to make sure that the wheels were down before landing.

Cessna 550—The aircraft was en route when it was struck by lightening. Maintenance found some exit marks in about ten different locations, notably the static air temperature (SAT) probe, the outside air temperature (OAT) probe, the left-hand elevator skin, and several locations on the left and right sides of the fuselage. No instrument damage or engine damage occurred.

Cessna 152—The pilots made a successful forced landing when the engine (Lycoming O-235-L2C) power suddenly decreased to approximately 1400 RPM. Maintenance found a bent intake valve pushrod caused the power loss.

Cessna 207A—Shortly after takeoff, the pilot smelled smoke in the cockpit and returned for an immediate landing. Maintenance determined that some oil had leaked from a valve cover onto the exhaust heat exchanger, causing smoke, which entered the cabin. The valve cover hold-down screws were loose where the leak was located.

Cessna P172D—After takeoff, the newly installed and overhauled engine started running very rough on the crosswind leg, then lost all power output. Maintenance performed a differential compression test and found that No. 3 piston was not moving when the crankshaft was turned. The crankshaft did not turn freely. The engine was returned to the overhauler.

Cessna 172L—The pilot reported smoke in the cockpit. The aircraft had to be jump-started because of a low battery; the subsequent high charge rate caused overheating of the 60-amp. circuit breaker (CB). Maintenance suspected the 60-amp. CB was likely deteriorated and could not withstand the high charging rate produced attempting to recharge the low battery.

Cessna 210A—The pilot declared an emergency as a result of a broken throttle cable. Maintenance found the rod end separated from the ball at the throttle arm. The throttle cable and mixture cable were both repaired, and the bolts connecting the airbox to the throttle body were lockwired.

Cessna 152—The pilot returned after the engine failed. Maintenance found that all the oil had blown out the breather, and since the factory-overhauled engine had only 126 hr. on it; they sent it back for analysis and repair. No further details are available at this time.

Convair 340—The flight crew declared an emergency and diverted for a landing. The aircraft landed without further incident. Company maintenance found and corrected a loose wire on the back of a canon plug. The director of maintenance advised that other aircraft in the fleet with similar canon plugs should be inspected for defective wires.

de Havilland DHC-2 Beaver—After departing over water, the seaplane's engine began to run rough, requiring a forced landing. Company maintenance later determined that the No. 9 cylinder of the aircraft's engine (model R985-AN14B; S/N 41-5530) was cracked.

de Havilland DHC-3—The pilot was in cruise flight when the engine started to run rough, so he conducted a precautionary landing on the lake. An AME was dispatched to the scene and he found the ear blown off one cylinder.

de Havilland DHC-6 Series 300—The aircraft returned to the field after departure to correct a problem. The problem was corrected by resecuring the main fuel cap.

de Havilland DHC-3—The pilot reported smoke in the cockpit and landed safely. Maintenance found that the heat ducting system had backed off and shorted out on the hot side of the circuit breaker panel where the terminals are left exposed. The circuit breakers were replaced and the ducting reinstalled more securely.

Douglas DC-9-32—The aircraft stopped on the runway as a result of a loud bang followed by loss of power in the left engine. Company maintenance determined that the No. 2 tire tread had separated. Rubber debris had damaged the left inboard flap, and a piece of rubber was stuck in the inlet guide vanes of the failed engine. Rubber ingestion is suspected to have caused the loss of engine power. All four main wheels had to be removed to enable recovery of the aircraft from the runway.

Douglas R4D-8—The pilot shut down because of flames coming from the wheel area. Maintenance found that a brake puck had leaked fluid onto the brake disc area. Heat from brake use likely ignited the fluid and carbon deposits. The brake caliper was replaced.

Firecat—The pilot observed an oil leak coming from the left-side propeller and, when he pushed the feather button, oil began gushing out from the feather line. Maintenance determined that the leak originated at the oil line fitting.

Fokker F28 MK1000—About 20 L of fuel leaked through the water drain plug from the aircraft parked on the ramp.

Fokker F28 MK1000—The pilot reported a lightening strike. Maintenance performed the required inspection and found a few minor pinholes in the aircraft skin.

Grumman S2P—The crew reported smoke in the cockpit while on the landing approach. Maintenance found the generator separated from one engine, causing an electrical malfunction. This created smoke, which entered the cockpit through the ventilation system. The generator mounting studs progressively failed until they were unable to support the generator, which dropped to the engine accessory section deck, causing some additional damage to electrical components.

Hawker Siddeley HS 748 Series 2A—The aircraft blew an oil line and the flight crew shut down the engine. Maintenance found that the threads of the oil pressure case fitting were worn, allowing it to leak. The fitting was replaced, and the engine was declared serviceable after a one-hour ground run with no signs of oil leakage.

Pezetel M-18A Dromader—The pilot force-landed after a power loss with substantial damage to the aircraft. Maintenance found that the exhaust valve pushrod for the No. 9 cylinder had been cut in two. The AME who examined the engine following the occurrence stated that he had carried out a top overhaul of the engine approximately 20 flight hours before the occurrence. During this work, the rocker arm on the No. 9 cylinder exhaust valve was found pitted and subsequently replaced with another rocker arm that had been used on an intake valve. The AME stated that when he referred to the maintenance manual (translated from Polish into English) he mistakenly interpreted that the valve rocker arms, which are reportedly very similar in appearance, were interchangeable but, because of angular differences, this is not true.

Piper PA-31T Cheyenne—The pilot advised that there was a pressurization problem and that no assistance was required. Maintenance found that a clamp on one of the air distribution ducts ahead of the pressure bulkhead had loosened off, allowing separation between the duct sections. The clamp was reinstalled and the aircraft was returned to service.

Piper PA-34-200—The pilot landed safely after declaring an emergency because of an engine failure. Maintenance found a leak and a bent pushrod at the No. 2 cylinder, which was the result of two nuts from the rocker arm wrist pin cover, at the cylinder head, backing off. This allowed the wrist pin to move to the right, bending the pushrod and affecting the valve opening thus creating the rough-running engine. Further inspection and repair are in progress, and all engines in the fleet with this style plate will be checked for retaining nuts security.

Piper PA-31 Navajo—During the flight, there was a drop in oil pressure, and the left engine was shut down. Maintenance found that an oil pressure line to the transmitter was not seated properly, causing a leak. The line was resecured, and the aircraft dispatched for another test flight.

Piper PA-31-350—The pilot reported an engine fire and landed safely. Maintenance found that a seal on the oil filter adapter (P/N CH48211) had broken, allowing oil to leak into the engine compartment, where it ignited after having contacted hot components from the turbo-charger mechanism.

Piper PA-44-180—The engine could not be controlled in flight by moving the throttle. Maintenance found that, during takeoff, the left throttle cable broke in the control pedestal area at the point where the cable enters the housing.

Piper Navajo—The pilot returned after experiencing an engine problem. Maintenance found that the turbocharger had failed because of a bearing seizure.

Sikorsky S-61L—The helicopter was heli-logging when it experienced an engine failure. A single-engine landing was executed without further incident. Maintenance found that the accessory gearbox was not being driven. It was later confirmed that the shutdown occurred as a result of an accessory gearbox pinion bearing failure.

Cessna 152 Rudder Locked Over the Stop

The aircraft failed to recover from a spin during a local training flight near Lac Saint-François in Quebec. The student pilot was practising spins and recoveries. After one and a half turns of the spin, the flight instructor asked the student to recover. The student applied pressure on the right rudder pedal, but the rotation did not stop. The flight instructor took over the controls and applied pressure on the right rudder pedal to stop the rotation, also without success. The aircraft struck the surface of Lac Saint-François, seriously injuring the student pilot and fatally injuring the instructor. The maintenance issues resulting from this accident are of concern to AMEs and aircraft operators. The findings in the report indicate that there were a series of maintenance deficiencies within the company system that may have contributed to the rudder becoming jammed (as shown in the photo) after the pilot applied full rudder input, which would be required to enter the spin.

The Transportation Safety Board Lab (TSB) report observed, among other points, that the rudder stop plate on the right-hand half of the rudder horn was firmly jammed behind its stop bolt on the fuselage. The rudder was deflected 34° measured perpendicular to the hinge line, whereas the maximum allowable deflection for setting the stops is 23°. When the rudder was released from its jam, the deflection was 23°. It required 36 lb of steady pull on the trailing edge of the rudder to break the rudder out of its jammed position. This steady pull of 36 lb equated to 180 lb if the force was applied to the rudder pedal. However, given that the direction of cable pull tended to increase the jamming by closing the horn, it would not have been possible for the pilot to break the rudder jam by applying the right rudder.

The examination also revealed that the aircraft's empennage had been damaged before the accident. The right elevator trailing edge had been broken and repaired with aluminium foil tape, and the rudder bottom tip had two cracks of about 1.5 in. extending from a rivet hole that had been stop-drilled and painted. No record was found of these repairs.

An inspection of the aircraft carried out by a technician the day before the accident revealed that the right pedal rudder bar return spring (P/N 0310196-13) and a spring attachment bracket for this spring, which was welded to the rudder bar assembly (P/N 0411526-2), were broken. The return spring supplied a tension force of about 10 lb per in. of stretch and balanced the force exerted by the matching left rudder bar return spring. The two return springs maintain tension in the rudder cables that connect to the right and left halves of the rudder horn. Without the right rudder pedal return spring, the right rudder cable slackens whenever the pilot maintains less than 10 lb of foot pressure on that pedal.

The broken pieces of the rudder control system were removed by the technician during the check but were not replaced. The technician then requested the opinion of an AME, the person responsible for company maintenance. The AME decided that the aircraft could be returned to service without being repaired. The defects in the rudder control system were not entered in the aircraft's journey logbook or technical logbook as required by the Transport Canada–approved company *Maintenance Control Manual* (MCM). On completion of the check, the aircraft was signed out in the journey logbook and in the technical logbook as being airworthy and was released to service. The person responsible for company maintenance presumed that the absence of the spring and bracket would not affect the flight characteristics of the aircraft and decided to release it for service until replacement parts could be installed. In reality, because the spring was missing, the aircraft was not airworthy. Further, the required entries were not made in either the snag book or the journey logbook. Had the logbooks reflected the defect and been available to the pilots, the flight instructor likely would have been aware that the rudder bar return spring was missing and would have had the option of refusing to operate the aircraft in that condition.

As an operator, the company had Transport Canada approval for two separate manuals as follows:

- An MCM, which stipulates that a flight training unit that operates an aircraft or a helicopter shall establish and comply with a maintenance control system that (a) consists of policies and procedures regarding the maintenance of aircraft operated by the flight training unit; (b) meets the requirements of this subpart; and (c) is described in the flight training unit's MCM.
- A *Maintenance Policy Manual* (MPM), which stipulates that an approved maintenance organization (AMO) certificate holder shall establish, maintain and authorize the use of an MPM that contains information to ensure the efficiency of the AMO's maintenance policies dealing with the subjects set out in Chapter 573 of the *Airworthiness Manual*.

In this case, the company MPM contained procedures that were in agreement with this standard. This required standard of airworthiness was not met on the accident aircraft because the company was using a snag book (not the journey logbook) for the flight instructors and pilots to report defects found on aircraft.

The journey logbooks were not available to students and instructor pilots for viewing or for recording times or defects. TC did not approve the use of a snag book in this case, nor were TC inspectors aware of the use of a snag book. The person responsible for the maintenance reviewed the snag book each morning and took note of all defects in order to take corrective action. A column for the corrective action taken was then completed by the person responsible for the maintenance once the defect had been repaired. No corresponding entries were made in the journey logbook.

The Cessna 152 does not operate under a minimum equipment list (MEL) system. It is therefore important to note in written records any airworthiness deficiencies and items required by CARs.

A review of the journey logbook and the technical logbook revealed that the company had not met all of the requirements of its MPM, as approved by Transport Canada, because the rudder control defect was not logged and corrective action was not carried out.

After becoming aware of the locked rudder accident, the manufacturer (Cessna) notified TSB investigators that it is developing a new design for the rudder horn stop bolt to preclude the possibility of over-travel of the rudder. Cessna has notified the Federal Aviation Administration (FAA) Aircraft Certification Office that it is developing a service bulletin to offer the new configuration for all models of 150s and 152s produced after 1966.

The actions proposed by Cessna to design a new rudder horn stop bolt assembly should provide protection against future jamming of the rudder—if the new design is installed on the aircraft. However, the service bulletin planned to offer the new configuration will not be mandatory; therefore, TC and the FAA are considering airworthiness actions.

The implications of removing the broken rudder bar return spring from the accident aircraft were not apparent to the the company maintenance personnel. However, the recent examinations and tests on similar aircraft types confirmed that the absence of the return spring, in combination with other factors—such as incorrect rudder rigging, poor condition of the rudder, rudder horn, stop plate and associated parts alignment—set the stage for irreversible jamming of the rudder during the rudder control inputs for spin entry.

It can therefore be concluded that the aircraft entered a left spin with the rudder locked at a 34° deflection. With the rudder jammed the way it was, no amount of right rudder pedal force would have released the jammed rudder because the direction of cable pull tends to increase the jamming by closing the horn.

Safety actions taken as a result of this accident include the redesigned part by Cessna as outlined in their service bulletin and Transport Canada–issued Service Difficulty Alert (SDA) No. AL-2000-04. Furthermore, effective August 4, 2000, TC has issued an airworthiness directive (AD), CF-2000-20, to address this issue with immediate mandatory inspection requirements.

Finally, the TSB recommended that The Department of Transport, in conjunction with the FAA, take steps to have all operators of Cessna 150, 150A and 152, 152A models notified about the circumstances and findings of this accident investigation and the need to restrict spin operations until airworthiness action is taken to prevent rudder jamming. This Maintainer article is intended to inform the widest possible audience of maintenance personnel about this serious concern for the possibility of jamming rudder assemblies on these aircraft. Also, the requirement to comply with TC AD CF-2000-20, which requires inspection and corrective action to ensure that the aircraft is in conformity with the maintenance requirements. *This information is condensed from the content of the report, TSB Report A98Q0114 LP 89/98, public documents available on request from the Transportation Safety Board of Canada.—Ed.*

Possibly Preventable Incidents

cont. from p. 2

the gear, then reported that he had fixed problem. The pilot landed the aircraft safely. Maintenance reported that, prior to the flight, the emergency hydraulic lever had been lifted or actuated to open the landing gear doors for a wheel well inspection by the crew. It is suspected that the lever was not fully stowed, allowing a bypass for hydraulic pressure and preventing the full retraction of the landing gear.

The pilot of a **Cessna 206G** was surprised when the aircraft started then unexpectedly lunged forward and struck another aircraft ahead of it. The struck aircraft suffered some damage to its rudder, tail cone and underside fin. *(The safety point is related to properly setting the park brake or use of wheel restraint during aircraft starting. —Ed.)*

The **Cessna 414A** was on an instrument flight rules (IFR) flight from Kirkland Lake Airport to Peterborough. Shortly after takeoff, both aircraft engines began running rough, so the crew diverted back to Kirkland Lake and landed safely. It was subsequently determined that the aircraft was incorrectly refuelled with jet A fuel instead of AVGAS 100LL and both engines will require replacing. A civil aviation safety inspector advised that the aircraft was in compliance with the AD requiring a fuel filler neck modification to prevent refuelling with jet fuel. The operator advised that the fuel nozzle on the Jet A fuel truck apparently does not have the flared nozzle it should have (the flared end of the nozzle was cut off).

The above incident is more closely related to a system or management problem than that of maintenance. I included it because

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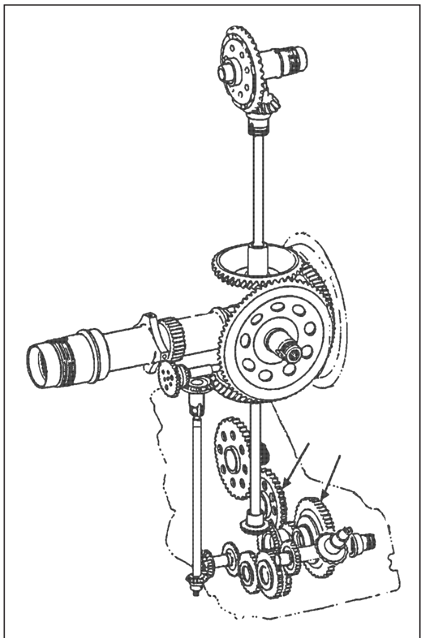
Bell 214B Accessory Drive Gears Fail



The TSB investigation revealed broken teeth on the accessory drive gears as depicted (arrows).

The helicopter was engaged in heli-logging operations and, after completing a turn in the hover, a low rotor RPM light illuminated and the engine decelerated. A forced landing was successfully carried out with substantial damage to the machine and minor injuries to the flight crew. A preliminary inspection of the engine determined that the accessory gearbox bevel drive gear that drives the fuel control unit was discontinuous. The rivets that secure the bevel gear to the shaft had sheared. An independent laboratory determined that the engine lost all power suddenly because a tooth on the accessory drive spur gear broke. The subsequent chain reaction jammed the spur gear into the oil pump drive gear interface. The resulting overload sheared a pin in the tower shaft, which stopped the drive to the gear box. The engine control stopped, and fuel delivery to the engine ceased, causing an immediate flameout.

The wear pattern on the gears suggested that there was a misalignment of the gears. It was also noted that the bearing liner bolts lost their torque, and the bearing liner had been moving in the cover bore. There was evidence of fretting between the bolts and the liner. The gearbox case and cover support bores were measured in a co-ordinate measuring machine to determine their size and true location. Five other used gearboxes were also measured for comparison. Most of the examined gear boxes had excessive wear and misalignment, including some greater than the failed gearbox, but none had failed gears. Subsequent to this failure, the company conducted tests and found that the value of the bolt installation torque falls after a couple of hours. This loss of torque is a result of an O-ring squeezing out from behind the bearing liner and the case. Insufficient torque allowed the bearing liner to move and cause wear in the bore. This is probably the mechanism that led to misaligned bearing bores and abnormal wear of the gear teeth. As a result, the company overhaul procedures have been modified to reduce the bolt torque loss. Allied Signal has recently issued Service Bulletin No. T5508D-0042 advising customers of a procedure for measuring alignment of the accessory gearbox case and cover bores.

Inspection and failure analysis of the accessory gearbox input spur gear using scanning electron microscopy and optical microscopes determined that the gear failed as a result of manufacturing defects. The spur gear was abnormal; it had been manufactured with an extremely hard and brittle surface that contained networks of micro-cracks. It was also found that the critical root zone had course machining or grinding marks. The mode of failure was fatigue, which initiated at several locations associated with the pre-existing microcrack networks. The fatigue fracture was not in the gear tooth contact areas. The abnormal loads placed on the gear teeth as a result of misalignment may have been a secondary factor in the gear failure.

Possibly Preventable Incidents cont. from p. 7

it is typical of an area where so much preventative work has been done, including special refuelling nozzles, tank filler neck restrictors and signs painted on the filler neck of aircraft indicating the correct fuel. Despite all these efforts, misfuelling accidents continue to plague the system and raise some unanswered questions. Is general aviation taking a serious view of refuelling aircraft and providing the proper training for those who perform the task? In this case, the one item, a flared nozzle, had been cut off, thus negating the safety inherent in the original nozzle. This is in addition to the fact that the pilot is always responsible for the safety and pre-flight of the aircraft. But why, after so much publicity, does this "Murphy" keep appearing? Is it due to lack of standard procedures? Is it due to neglect of existing procedures? I think this incident provides operators and managers some food for serious thought about the care required when refuelling aircraft. —Ed.

The pilot of a departing **Piper PA31P-350** advised that he had an oil leak and was returning to land immediately. After the aircraft landed, it was determined that oil was coming out of the filler neck because the oil cap was not properly secured.