Transport Canada Transports Canada

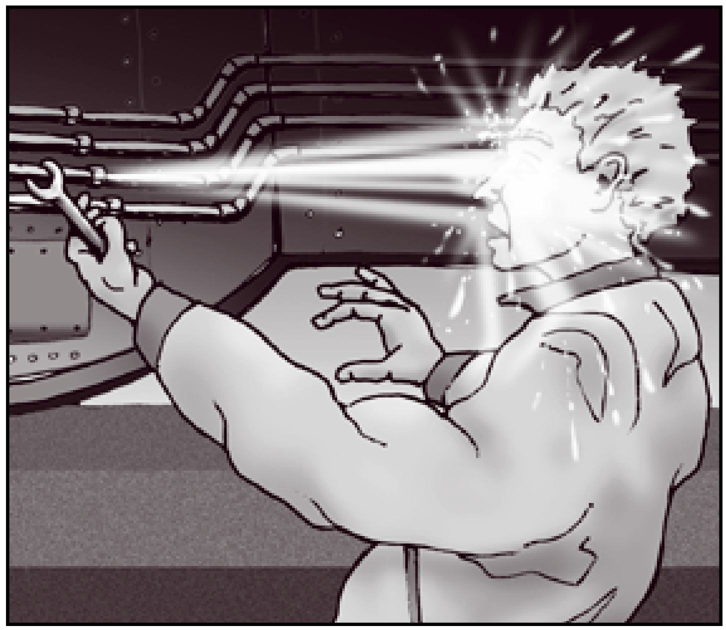
Aviation Safety

Maintainer

Learn from the mistakes of others and avoid making them yourself . . . **Issue 1/2003**

Assertiveness and Pressure — Human Factors

"It is better to be careful 100 times than to be killed once."—Mark Twain



At first, it seemed like a simple repair. There was a hydraulic system leak threatening to ground the aircraft unless a new line could be found. It was late in the day, and a replacement was not possible for another 24 hours; however, the aircraft had to be returned to service within a couple of hours because there were passengers waiting. Someone had the idea that any high-pressure line could work if one of proper length could be found. There was a maintenance shop nearby that serviced large jets and its maintenance engineers had developed their own emergency kits just for such instances. The new line had no certification tag but it looked new and serviceable. And after all, the next day we would get the proper part and all would be right in the world again…right?

The new part had been fabricated for another make of aircraft and unbeknownst to everyone, the pressure resistance was half of that required. Nevertheless, an engineer was given the task of fitting the new part. When the line seemed secure, hydraulic pressure was restored and the line held the pressure. A flight was undertaken, but shortly after takeoff a low hydraulic quantity light came on and the flight had to return and land. As an aircraft maintenance engineer (AME) was inspecting the line, it suddenly burst and sprayed Skydrol all over his face, blinding him and drenching his work clothes and skin.

There were no emergency eyewash or chemical burn stations anywhere nearby nor were there any portable eyewash bottles available. A colleague had the quickness of mind to take the blinded and suffering AME to the aircraft lavatory and assist him in washing his face and eyes with water from the sink. This probably saved his eyes. He suffered first-degree burns to his face, neck, hands, arms and a number of other places on his body.

AMEs work hard to ensure that a flight can be dispatched on time and many are recognized as real magicians when it comes to troubleshooting aircraft systems and repairing discrepancies efficiently and sometimes creatively. But they don't always do it by the book. It is a tough world and the competition is fierce. Your health is important! Yes, we can take the pressure, but within reason. This means not letting ourselves go beyond recommended practices and setting aside our values as professionals in this very specialized field of aircraft maintenance. Sometimes quick solutions may be counterproductive, downright dangerous and very costly. Keep in mind, assertiveness is safety and peace of mind.

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Canada

There Were Four Deaths

The Britten Norman Islander is known to be a fine aircraft. High-lift wings, excellent and efficient design, some of the best engines, but still, the crew could not manage to return to base after a brief flight in light icing conditions. Soon after takeoff, and upon retracting the flaps, the aircraft showed that it was loosing lift. The pilot made a shallow turn to return for landing and the plane entered a stall from which it could not recover. It crashed nose-down into the sea. There was only 2 ft of water at first, as the tide was low, and since the emergency locator transmitter (ELT) had not been properly installed, it did not activate.

Two hours passed before the rescue efforts started, when a boy playing nearby observed the airplane 300 m from shore and notified authorities. The two engines were functioning on impact. But were they developing the power that they should have been producing? Investigation of the left engine revealed that cylinders 2, 4, 5 and 6 showed signs of blow-by and the compression rings for pistons 1, 2 and 4 were broken. The rocker arms for cylinder 6 had been reversed at installation. Examination of the right engine revealed that the model of piston used for cylinder 3 was incorrect; a low compression model had been installed instead of a high compression one. Pistons 1, 2, 4, 5 and 6 showed signs of significant blow-by. The compression rings on pistons 1, 4, 5 and 6 were broken, the head of piston 5 was punctured, the wear on piston 6 exceeded the manufacturer's standard and it was cracked on the bottom of the forward scallop. According to the maintenance schedule, one cylinder in each row should have been removed to allow internal examination of the engines. This examination should have been entered in the engine log. No documentation indicating that this work had been done was found in the aircraft technical records.

Ref.: TSB Report A98Q0194

Flight Controls: Incorrectly Assembled and Inspected

A Piper Cherokee-140 was being flown VFR by the owner and a friend, who was also pilot, following a recent annual inspection. Aileron bell crank brackets had been replaced during the inspection and the owner wanted to confirm that the aircraft had been repaired according to the requirements. During the climb out, at an altitude of approximately 25 ft, the aircraft banked to the left, and the pilot who was flying at the time, tried to correct the situation by applying the right aileron, but the aircraft continued turning to the left. The other pilot tried to straighten the aircraft but the ailerons jammed in the full-right position. The aircraft flew over a highway and the left wing tip collided with a snow bank. The wing separated and fuel was spilled, but the aircraft did not catch fire. The two pilots evacuated the aircraft and were taken to hospital for minor injuries.

The investigation revealed that the bell cranks had been reinstalled backwards. The checklist used by the pilot provided three opportunities to notice the discrepancy, but somehow it went undetected. Human factors that may have influenced the aircraft maintenance engineer (AME) and the outcome of this situation are the following: pressure and/or stress, lack of resources, fatigue, complacency, distraction, lack of awareness, and lack of teamwork. The aircraft owner had asked that the work be performed before the Christmas break. However, the maintenance company was short on AMEs, so the work became more labour intensive as it became very difficult to remove the fuel tanks. The AME elected to do the work from memory as the microfiche reader could not produce hardcopies. Two AMEs inspected the controls and signed the logbook, attesting that the inspection had been performed and that the work met the specifications. The report states that the AME who performed the work did it from memory because he had done similar work several times before. The procedures of the maintenance manual were not followed, and the airplane crashed. The question is: Do you think that a checklist could have prevented this event?

Considering the risks involved when performing maintenance on an aircraft, do you think that someone could be faulted for taking a few minutes here and there to review a checklist of items to do, as well as to check the items that have been inspected, and do a final review of the area for foreign object damage (FOD)? It would definitely save a lot of heartaches. Always use a checklist, as it gives you one more fighting chance against all odds.

Ref.: TSB Report A01Q0009

Transport Canada / Transports Canada

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Dr. Robert Waldron Wins the Transport Canada Aviation Safety Award

The Minister of Transport, the Honourable David Collenette, presenting the award to Dr. Robert Waldron.

Transport Minister David Collenette presented the 2003 Transport Canada Aviation Safety Award to Dr. Robert Waldron for his commitment to aviation safety in Canada. The award was presented in Montreal on April 15, 2003, at the 15th annual Canadian Aviation Safety Seminar (CASS). CASS is an international event hosted annually by Transport Canada for all sectors of the aviation community.

"Throughout North America, Dr. Waldron is recognized as an expert in aircraft accident investigation, and though his technical achievements are impressive by themselves, his integrity and perseverance has also gained him the respect of his peers, manufacturers, the insurance industry, and the international aviation industry," said Mr. Collenette. "Through his accident investigations, Dr. Waldron has contributed to aviation safety worldwide in a profound and tangible manner. I congratulate him on receiving this well-deserved award."

Dr. Waldron received his Ph.D. in metallurgical engineering at the University of British Columbia. He established the firm R.J. Waldron & Co. Ltd., specializing in aviation and accident investigations. He has worked on more than 500 air accident investigations in 25 countries involving various types of airplanes and helicopters.

One of Dr. Waldron's most noteworthy cases was his investigation into a fatal accident in 1979 of a de Havilland Twin Otter aircraft. His investigation prompted Transport Canada to issue an Airworthiness Directive requiring inspection of Twin Otter aircraft worldwide. As a result, the entire flight control system of this aircraft was modified.

The Transport Canada Aviation Safety Award was established in 1988 to increase awareness of aviation safety in Canada, and to recognize individuals, groups, companies, organizations, agencies or departments that have contributed, in an exceptional way, to this goal.

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Mechanical Happenings

As reported from the TSB, NTSB[1] and CASA[2].

Aerospatiale AS32 : It had traveled approximately 25 mi. for Oil Platform, when the pilot requested a turn-back clearance due to a No. 1 Engine "Check Engine Light" which had illuminated. The helicopter landed without further incident. The return to base incident that occurred was caused by a loose electrical chip detector on the left hand engine. The chip detector was tightened, re-seated and ground checked as serviceable. The aircraft was released for return to service.

Boeing B747-400 : More recently, an upper wing inspection panel blew off a B747-400 and fell into a parking lot, just 800 yd. from a local police station. The police called the airline; and the airline called the pilots, who looked out the window and confirmed the panel was missing. The airplane discontinued its planned flight and returned to land.

The airplane was put back into service with maintenance work still to be done and the panel held temporarily in place by just four screws; about three percent of the 125 needed for complete installation. The failure to install the full battery of screws in the inspection panel was serious, but not fatal—only because of the surface involved.

Boeing B747-400 : A B747-400 lost a right hand, trailing edge, inner fore-flap. A local fisherman found the part in the harbour, near the departure airport, at about the same time the crew was preparing to land 4 000 mi. away and could not get the flaps to move to the desired setting. Another part missing from the assembly washed up on the beach about two weeks later. In this event, the culprit seems to have been metal fatigue.

Boeing 767 : During climb-out, an airframe vibration developed. All gauges, readouts, synoptic pages, and airplane controls were normal. The crew contacted their maintenance base and attempted to troubleshoot the problem, but could not determine its cause. The vibration remained unchanged until the airplane leveled off at 7 000 ft during an approach. At that time, the crew felt a bump, then the vibration completely ceased. The airplane landed and taxied to the gate without further incident.

Post-flight inspection revealed that the No. 1 exhaust fairing was missing, and that the left, aft fuselage had a dent. The 30 bolts that would have normally attached the exhaust nozzle assembly to the exhaust frame were all missing, "without a trace." Seven months earlier, the tailpipe was found loose. Ten bolts were replaced, and the rest were re-torqued. The last inspection on the airplane had been completed about two weeks earlier, 105 hours prior to the incident. Company personnel had previously found cracked bolts on exhaust flanges from other engines. Laboratory examination of used bolts from another engine revealed no anomalies. Engine shop buildup and shop exit manuals were subsequently revised to make the installation and torquing of exhaust nozzle bolts a required inspection item.

The NTSB determined the probable cause(s) of this accident/incident as: missing exhaust nozzle bolts for undetermined reasons. A factor was inadequate maintenance inspection of the affected area.

Boeing KC 135 : The aircraft had been overhauled and was being pressurized on the ground to check for leaks and to make sure the pressurization system was working properly. The outflow valve had been capped off during the overhaul. The technician who was monitoring the pressurization process was using an uncertified gage that had no maximum peg to prevent the needle from jumping over and going around the scale another time. The engineer missed the needle as it traveled once around the scale and noticed it going twice around the gage, backward, as it lost all compression when the rear bulkhead exploded and was thrown 70 yd. from the aircraft. The aircraft was a total loss. The technician remarked afterwards that he had always done it that way.

Concorde : The British Civil Aviation authority (CAA) TSB report on the crash of the Concorde revealed that one of the front nose-wheel tires collided with a foreign object as it was taking off and a puncture resulted that sent debris into the fuel belly tank and ruptured it, causing the ensuing blaze and crash. The metal shim from a DC-10 thrust reverser cowl was a repair performed without any engineering substantiation.

It also mentions that Air France had replaced a bogie on the left main gear, and that a technician failed to insert a 12 in. spacer in the landing assembly to hydraulic jack linkage, that forced the nose gear to track sideways slightly as the aircraft was taking off, thereby exerting unnecessary stress on the nose-wheel tires. The resulting explosion of the high-pressure tire was equivalent to about four sticks of dynamite.

Douglas DC-8 : According to the pilot, the freighter flight was normal in all aspects until the landing gear was extended for landing at destination. The left main landing gear (LMLG) indicated "unsafe," and all attempts, using the emergency/abnormal checklists and telephone/radio-relayed communications with company maintenance, failed to extend it.

An emergency LMLG-retracted landing was performed with minimal damage to the aircraft. Postcrash investigation revealed that company maintenance installed a one-way check valve in the LMLG extend hydraulic lines instead of a restricted flow valve. The valve, which was installed incorrectly, had no factory specification or part number attached, and the tag, which was reportedly removed at installation, had the wrong factory specification number, but the correct vendor' s part number. The company maintenance manual states that upon completion of the valve installation, a leak and operational test of the MLG retract/ extension system be performed. The valve installation mechanic and the company inspector both stated that the finished job was leak- and "ops-"tested.

The NTSB determines the probable cause(s) of this accident/incident as follows: the failure of company maintenance personnel to install the correct hydraulic landing gear extension component, and the failure of company maintenance inspection personnel to comply with proper post maintenance test procedures, resulting in the impossibility of the LMLG to extend, and the subsequent LMLG-up landing. A factor in the accident was the improper identification tag marking on the replacement component, and no marking on the component itself.

Embraer EMB-120: In 1991, all 14 passengers and crew were killed when the horizontal stabilizer separated in flight. Maintenance personnel had failed to install *any* of the 47 screws needed to affix the leading edge of the stabilizer.

McDonnell Douglas MD-11F: The aircraft experienced a flight control malfunction during final approach. The flight crew performed a missed approach, declared an emergency, and diverted. During landing, the airplane experienced a tail strike. The airplane was substantially damaged in the area of the flight control malfunction. According to flight crew statements and digital flight data recorder (DFDR) information, the takeoff, climb, cruise, and descent of the accident flight were uneventful. As the airplane was on final approach to landing, the flight crew selected flaps 50 (full extension) and continued to approach the runway. About one minute later, as the airplane was flying about 1 500 ft above mean sea level, the flight crew heard a loud bang and felt the airplane shudder. The airplane then began to roll to the left, and nearly full-right control wheel input was required to counter the left roll. The flight crew initiated a missed approach, declared an emergency, and diverted to another airport. During the diversion, airplane controllability was marginal in the roll axis, and the flight crew took turns holding nearly full opposite control wheel. The flight crew noted cockpit indications of asymmetric flaps, deployed spoilers on the left wing, and a failure of the No. 3 hydraulic system. During landing, the airplane experienced a tail strike. The airplane rolled out from the landing uneventfully and taxied to the ramp.

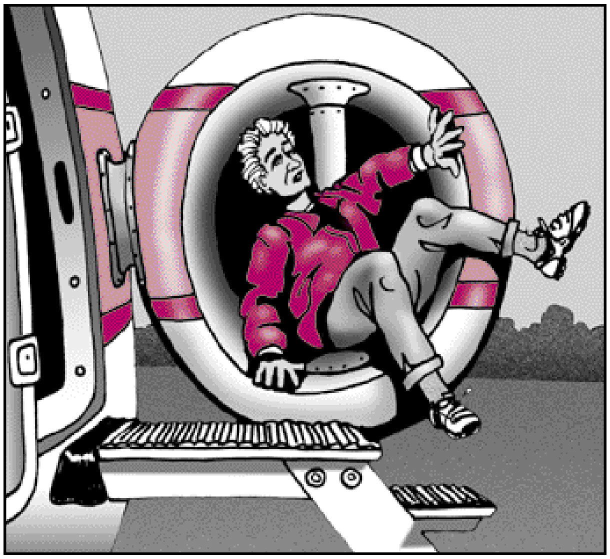
Post-flight inspection of the airplane revealed that the left-wing inboard flap outboard hinge had pulled away from its attachment to the wing trailing edge and dropped downward. Cable pulleys and linkages associated with the roll control system were attached to the hinge and also pulled away from their normal positions. In addition, two hydraulic fluid lines in the area of the hinge were compromised. The flap was found damaged and jammed toward the downward outboard direction. A flight spoiler was found deployed in the fully extended position, and the left-hand inboard wing trailing edge beam assembly was deformed upward. Detailed examination of the left-wing inboard flap outboard hinge revealed that two of its four attach bolts had failed. The two lower 7/8-in. diameter steel bolts had failed, while the two 5/8-in. diameter upper bolts remained intact. Examination of the failed bolts revealed evidence of corrosion. Their associated nuts and washers were also cracked. The bolts are currently undergoing detailed metallurgical analysis.

The accident aircraft had accumulated 37 439 flight hours and 9 241 landings. It was the first production MD-11 built, and had been initially used by McDonnell Douglas as a test-flight airplane. As a result of this accident, and subsequent inspections of other older MD-11s, the Boeing Company issued alert *Service Bulletin* (SB) no. MD11-57A067, on July 10, 2002, that recommended the examination and/or replacement of MD-11 inboard flap outboard hinge lower attach bolt assemblies with new nuts. The FAA immediately issued an *Airworthiness Directive* (AD) to mandate the SB.

Robinson R 22: A recent report from the Australian Transport Safety Bureau brought to light a very dangerous business which consists in under-reporting flight time of aircraft and aircraft components. In this instance, the Robinson helicopter lost the main rotor blades; the pilot did not survive, and the passenger sustained serious injuries. To quote from the report "the investigation found that the failure mode of the main rotor blade was identical to the failure mode documented in a 1990 occurrence and on the manufacturer tested-to-failure blades." The information was gleaned following a comparison of the helicopter logbooks, company invoices and parts, and fuel usage.

As an aircraft maintenance engineer you are aware that the airworthiness of an aircraft and that of its systems relies on conformance to its type design, its operational specifications and strict adherence to the manufacturer's maintenance schedule. As one can see, any deviation can create a situation where lives are put at risk.

The Cost of Ground-handling Accidents and the Regulations



Ramp worker narrowly escapes being ingested by the engine of a Boeing 727 —The captain of a Boeing 727 had arrived at the gate and left the No. 1 engine running at idle power because he could not get the aircraft to accept external power. Suddenly, the senior flight attendant came running up the aisle calling for the engine to be shutdown as somebody had been sucked inside. The captain immediately complied and then rushed out to investigate. Fortunately, by this time, the catering truck supervisor had been removed from the engine intake; he said that he didn't know that the engine was running. The catering supervisor had approached the rear aircraft door from the elevated walkway of the truck and had been immediately sucked into the turning engine. The engine suffered foreign object damage (FOD) and the man suffered a number of broken ribs, but amazingly he avoided major injury thanks to the quick intervention of the crew and the fact that the engine was equipped with fixed external guide vanes.

Boeing 747 collides with ground power unit (GPU) vehicle —The aircraft was being prepared for a flight. The ramp operations were almost completed when the co-pilot requested taxi clearance from the apron controller. Clearance was issued and the captain started to taxi the aircraft. A ground handler and a GPU vehicle were still situated under the aircraft. After the aircraft had taxied about 85 ft, its right-wing main landing gear struck the GPU vehicle and pushed it approximately 3 ft before the captain stopped the aircraft. There were no injuries; however, the aircraft sustained minor damage to two main wheel tires and to a wheel-well door. The incident occurred in daylight conditions.

De-icing an aircraft in winter can be dangerous —A Boeing 747-400 was parked in the de-icing centre and was being prepared for a scheduled flight. Its four engines were running. The crew heard the phrase, "de-icing completed," and the captain asked the co-pilot to inform the apron controller that the aircraft was ready to taxi. Taxi instructions were issued. The aircraft started to move forward and overturned the two de-icing vehicles that were still in front of the aircraft's horizontal stabilizers. The two vehicle drivers sustained minor injuries, but the three occupants of the nacelles (cherry pickers) did not survive the accident.

A recent survey by the Airport Council International (ACI) found that ramp damage to aircraft, airports, structures and ground-service equipment costs the global airline industry US$3 billion annually in uninsured losses. This translates into a ticket premium of US$3 on average, for each traveler. Furthermore, airlines are using a guideline figure of US$500 per minute for the cost of delays due to ramp damage. Any airline operating 100-plus aircraft can expect to have, on average, one of its aircraft in the hangar undergoing ramp damage repairs every day of the year. Direct cost for ramp damage of a narrow-body aircraft is approximately US$75 000, while indirect costs can reach US$230 000. The cost for repairs on a wide-body aircraft can total US$450 000.

Danger of engine and airframe damage from FOD such as the kind that downed the Concorde not very long ago—as well as the danger of fuel spillage, creating the potential for fire and explosion, is forever present. There is a high risk of being ingested by the suction of a jet engine as we unknowingly let our guard down after the third overtime shift of the week, with little sleep in between. The potential hazards are heightened by a noisy environment; tasks have to be performed quickly and professionally in all kinds of weather, poor lighting conditions, and with little communication between workers. A truck driver who is afraid of reprisal will often not report collision damage to an aircraft's structure, which could later cause a serious event of decompression in flight. As an aircraft technician or service equipment worker, you have no doubt experienced the awesome power of a turboprop or jet engine blast, when it scared you and made you lose your footing on the wet tarmac and fall to the ground, narrowly escaping injury.

Human factors are being redefined by various organizations that are concerned with the advancement of aviation and the safety of all of its workers. These organizations strongly acknowledge the countless number of individuals who provide the necessary services for each successful flight. Moreover, encouraged by studies and surveys made by the International Civil Aviation Organization (ICAO), they are adopting and promoting new rules to ensure the safety of these workers. In 2001, at the 10th Annual Forum for the Canadian Aviation Maintenance Council (CAMC), Human Resources Development Canada (HRDC) announced funding of over CAD$1 million for the development of national standards for aviation fuelers, aviation ground services personnel, aviation support services personnel and aviation special process technicians. Since 1991, CAMC, in partnership with HRDC and industry, has been developing national occupational standards for 15 aviation maintenance trades.

According to the Honourable Ethel Blondin-Andrew, Secretary of State, House of Commons, "These functions directly impact on the airworthiness of aircraft and safety, resulting in productivity gains and improved competitiveness for the Canadian aircraft industry."

We'll keep you posted.

Turbomeca Arriel 1 Engines and the Risk of Rear Bearing Failure

Only four grams of accumulated sand or dust, which flakes off the inner walls of the gas generator shaft section of the Turbomeca Arriel 1 engine, can have a catastrophic effect on the rear bearing. The pilot can experience a very sudden engine failure, and if he's doing heli-logging or fire fighting, it is likely that a crash will ensue, as he has very little margin for error and very few safe-landing sites available. Four grams is about double the amount of salt that you put on your fries—it's not very much. The *Airworthiness Directive* (AD) 90-064B and the *Turbomeca Service Bulletin* A292 72 0230 emphasize the importance of regular inspection, adhering to the maintenance schedule adapted to operations in dusty environments, and the use of an air filter to lower the risk of the ingestion of dust and sand when operating in a dusty or corrosive environment. Construction sites, heli-logging, crop-dusting, cement factories, and areas where volcanic ash may be present are only a few examples of where these conditions exist. As an aircraft maintenance engineer, your responsibility is to ensure that the necessary steps are taken to prevent this type of engine failure. The air filter is a great help, but cannot prevent very fine dust particles from entering and accumulating in the engine. The risks remain, and only the diligent application of the manufacturer's recommendations can ensure the continued airworthiness of this engine. You may not have been made aware of previous exposure of the engine to such an environment, so strict adherence to the AD requirements will help ensure safe flight. Remember, you have the last say on airworthiness.

Call for Papers—CASS 2004: The Future of Aviation Safety

The 16th annual Canadian Aviation Safety Seminar (CASS) will be held in Toronto, Ontario, April 19-21, 2004. The theme for CASS 2004 is "The Future of Aviation Safety." The challenges that the industry and the regulatory bodies will face during this decade is daunting, to say the least. The invited speakers will offer solutions and insight on important issues such as: safety leadership, safety planning, organizing for safety, organizing for control, managing safety performance, managing human resources and many other strategic subjects that confront industry leaders today.

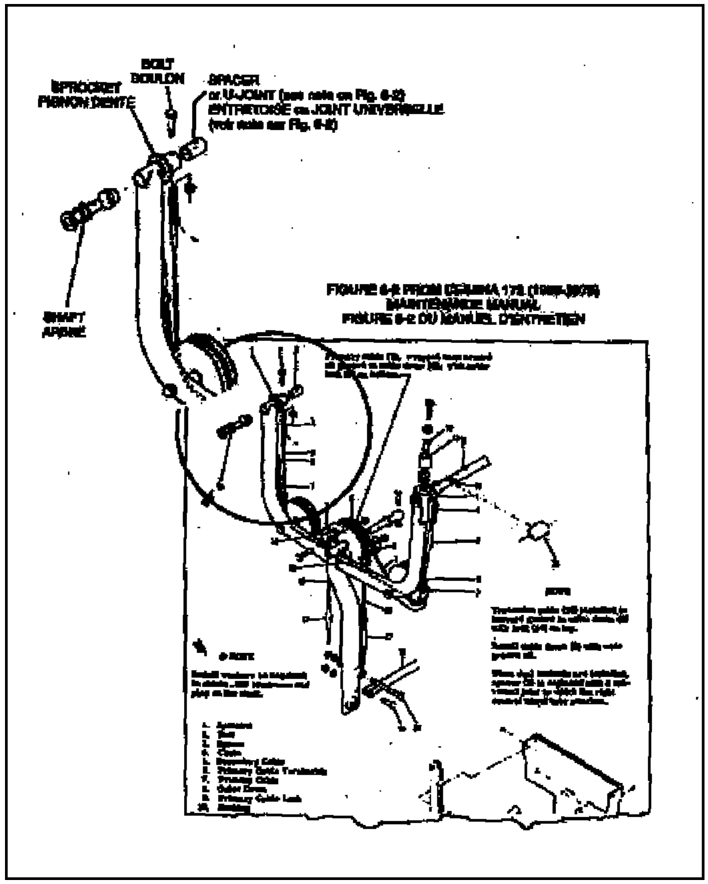
If you wish to present a paper at CASS 2004, please complete the instructions found at http://www.tc.gc.ca/CASS/. Drafts must be submitted by **Monday, August 25, 2003**. Selection will be made on the basis of content and applicability. Complete work will be due on **Monday, Feb. 23, 2004.**
For assistance, please contact Bryce Fisher, Manager, Safety Promotion and Education, (AARQB), Transport Canada, Ottawa ON K1A 0N8 Canada. E-mail fisherb@tc.gc.ca Fax: 1 613 991-4280.

The 17th Annual FAA/CAA/Transport Canada Safety Management in Aircraft Maintenance Symposium will be held this September 16, 17 and 18, at the beautiful Fairmont Royal York Hotel, 100 Front Street West, in Toronto. The theme this year is Integrating Human Factors Principles. For reservation in North America, call 1 800 257-7544; internationally, call 506 863-6310; fax your request to 416 368-9040. The special conference rate is $209 plus applicable taxes. You may contact Krissi MacDonald, Symposium Coordinator at 613 952-4375 or macdonk@tc.gc.ca, for any additional information. This is an event on Aviation Safety that shouldn't be missed. We hope to see you there.

Human Factors at Work Again

The Cessna 172 was on a VFR flight carrying four people when, at an altitude of 5 500 ft ASL, the right-hand aileron yoke assembly came apart, and the pilot lost lateral control. He immediately declared an emergency and the control centre guided him to the airport, where emergency services were standing by. The elevator was functioning normally, but the pilot used it as little as possible for fear that the flight controls might jam completely. He successfully landed without incident and no one was injured.

On 7 April 2000—four days before this last event—following the annual inspection of his aircraft, the pilot took off at about 16:45 eastern daylight time (EDT). Approximately 13 mi. away, at an altitude of 2 700 ft, the pilot noticed that the aileron control was no longer responding. Using the elevator, its trim tab, and the rudder, the pilot managed to turn back and set the aircraft down on the runway. The landing proceeded without incident, and the pilot did not declare an emergency.



When the pilot arrived at the hangar, all the employees, except for the maintenance manager, had left the premises. The maintenance manager checked the malfunction and found that the right-hand aileron yoke assembly had come apart and that some parts had fallen onto the floor of the aircraft. He re-did the work himself. The pilot's lack of a night rating put additional pressure on the maintenance manager, who rushed to complete the work before it began to get dark. He put the universal joint back in place, checked the operation again, and returned the aircraft to service without making technical entry and without asking anyone else to perform an independent inspection. The pilot took off again at 18:25 EDT, and the flight proceeded without incident. The maintenance manager, who was involved in the work, had over 20 years of experience in aircraft maintenance. During the 7 April 2000 annual inspection, an apprentice technician had taken part in the installation of the aileron control system, and the maintenance manager had checked the work. Yet the aircraft had been returned to service with the aileron yoke assembly incorrectly installed.

The work on the yoke involved rotating two identical parts from one side of the flight control to the other. The two mechanisms were similar, but access to the right side was restricted by the presence of radio equipment and the card box. This work was simple enough for the maintenance manager to allow an apprentice technician, who had only one year of experience, to perform the work without constant supervision. The apprentice technician was, however, supervised by a more experienced apprentice technician. For economic reasons, the maintenance manager had suggested to the aircraft's owner that the universal joints be rotated instead of just replacing the left joint. By so doing, he increased his maintenance staff's workload, and the risk of error, without contravening the regulations. The pilot performed a pre-flight check, and all the flight systems were functioning normally. Aeronautical maintenance professionals require a number of skills and are subject to a variety of pressures. Among other things, they have to keep aircraft airworthy, perform maintenance on ageing fleets, and cope with other stress factors that affect their performance. The serious consequences of a flight or engine control installation or an adjustment error are well known to the industry and to Transport Canada. That is why engine- and flight-control maintenance is treated differently from other maintenance work, in that an independent inspection is required upon completion of such maintenance work. In both occurrences, no entry certifying that an independent inspection had been done was made in either the aircraft journey log or any other technical log. The investigation revealed that, in both occurrences, the aileron control system had been incorrectly installed, resulting in the aircraft's loss of lateral control in flight.

Ref.: TSB Report A00Q0043