Transport Canada / Transports Canada

Aviation Safety

Maintainer

Learn from the mistakes of others and avoid making them yourself . . . **Issue 3/2003**

Concorde

Remember the Dirty Dozen—Human Factors can lead to mishaps that leave behind nothing but unrecognizable parts and some important lessons to be learned. Human Factors are intertwined closely with risk management, and accidents are often a result of an organization's failure to adopt a safety management system (SMS).

The Concorde…what an aircraft! What an engineering and technical feat! A project that brought together the great minds and abilities of two great nations; two nations with many opposing views on culture, language and life. Nevertheless, they had a common goal: to create an airplane 25 years ahead of its time. The Concorde stimulated a generation of British and French aerospace entrepreneurs who went on to develop some of the greatest aircraft in the world. The Concorde started the globalization of world markets by bringing efficiency of transportation to new heights. The Concorde became the wonder of the sky, breaking down time barriers and stimulating world economies. But, it is no more.

The Concorde took off on a flight from Paris, France to New York, USA, on July 25, 2000. During the take-off roll, and just before rotation, a front right landing gear tire ran over a strip of metal and was damaged. It burst into several pieces and debris was projected against the left wing fuel tank No. 5 outboard skin, which ruptured and sent fuel that ignited immediately as it came in contact with hot exhaust gases from the engines. The No. 1 and No. 2 engines lost power and No. 2 was shut down. The No. 1 engine was operated briefly at idle power due to a fire warning alarm, and the aircraft took off as it was too far into its take-off run. The landing gear would not retract because of hydraulics failure and the aircraft could not gain height or speed. It flew for about 1 min when the No. 1 engine lost power, the angle of attack and angle of bank increased, the No. 3 and No. 4 engines lost power and the Concorde, uncontrollable at this point was lost.

The French civil aviation investigation bureau, the *Bureau d'enquêtes et d'analyses pour la sécurité de l'aviation civile* (BEA), found that during the take-off phase, the tire on wheel No. 2 was cut by a metallic strip on the runway. The part came from the thrust reverser cowl door of engine No. 3 on a DC-10 that had taken off 5 min before the Concorde. It had been replaced twice in the last two months; once in June and once in July of 2000. The second time that it was replaced, it had neither been manufactured nor installed in accordance with procedures defined by the manufacturer. "The loss of the wear strip from the thrust reverser door on the Continental Airlines DC-10 originated from a lack of rigorous maintenance. The part was not in accordance with the manufacturers specifications. Of course, this is not a critical part from an airworthiness perspective, but true safety implies strict respect for procedures, without any personal interpretation. Facts established concerning the metallic strip and the aircraft reveal inadequate adherence to maintenance procedures by the various workshops that carried out the work on the reverse cowl." (BEA)

In order to return the Concorde to service, the BEA recommended that a flexible fuel tank liner be installed to reduce the risk of fuel leak following damage, and the possibility of a shock wave that

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could induce fuel instability and fuel tank rupture. It also recommended the installation of new reinforced Michelin tires that would have improved impact resistance qualities. There were modifications made to the landing gear water deflectors and reinforcements made to the wiring of the main undercarriage area. It further recommended that operators adopt a feedback process, SMS*, that would provide through analysis of in-service accidents, a process to identify and rectify safety issues before they could ever become an accident with tragic consequences. Several Concordes had sustained tire failures, and fuel tank damage due to impact from tire or foreign object damage (FOD) debris prior to July 25, 2000.

*An SMS is an accident prevention system that can be integrated within a quality assurance system. Its objective is to achieve and maintain risk awareness by all persons involved in the operations. This will lead to enhanced safety performance, as its goal is to promote best operational practices. Employees and the organization can best define these parameters of risks and move beyond compliance with minimum regulatory requirements, all the while improving the efficiency of the organization.

SMS is a systematic management approach to all observed and presumed risks associated with any complex enterprise. In aviation, it covers flight and ground operations as well as engineering and maintenance and will help achieve the levels of safety that this mode of transportation requires. SMS should be an explicit philosophy for the corporate management team that sets out safety policies and defines the process by which it intends to manage safety. In civil litigations, being able to show that all of the necessary requirements, even those beyond the ones required by Law, were met could assist the court in ruling in favour of this organization. Adopting an SMS is ensuring the survival and progression of your organization through future changes and challenges of aviation. It offers a positive safety culture to any organization that has at heart the success of its safety performance program.

Would SMS have made a difference in the case of the Concorde? The recommendations of the BEA seem to indicate that it would have.

Cordless Screwdrivers: How Safe Are They?

Of all the tools devised to tighten and loosen fasteners, cordless drills and screwdrivers have a definite advantage over others. They are light, efficient, reliable, and take the pain out of any fastener work. But like all tools, they deserve respect if we hope that they will perform to their design specifications and ensure the airworthiness of any job accomplished on an aircraft. For instance, is your cordless screwdriver certified for use in and around flammable liquids and vapour? After all, today, it is used everywhere around aircraft. How sure are you that your portable screwdriver performs to specific torque values after months of use, if it is not tested regularly? Is it identified on the list of tools that are rescheduled for verification of torque accuracy? Is it certified for use in an environment where flammable chemicals and vapours are present?

A case in point: A maintenance technician had removed a Cessna 421C wing fuel tank access panel in order to carry out the replacement of a fuel valve located inside the fuel tank. As he proceeded to remove some of the fasteners inside the fuel tank, a spark from his cordless screwdriver ignited the fuel vapours remaining in the tank. The explosion was so violent that the maintenance technician lost his life and the aircraft was substantially damaged. The investigation revealed that the failure to purge all fuel and fumes from the fuel tank, coupled with the fact that the cordless screwdriver was not certified explosion-proof, led to the accident. In another recent accident, an aircraft maintenance engineer (AME) was removing a helicopter fuel tank access panel while there was still a small amount of fuel remaining in the tank. As the screws were being removed, fuel dripped onto the portable screwdriver and ignited the fuel and the fuel tank. Fortunately, through prompt action of co-workers with quick access to fire extinguishers, the fire was put out and the helicopter saved. Unfortunately, the engineer suffered third degree burns. In another incident, a complete aft turbine engine exhaust pipe module fell off the aircraft in flight. It is thought that fasteners weren't tightened to specifications. Cordless screwdrivers are very handy but you, professional AMEs, are responsible to ensure that their performance meets aircraft environment conditions. Ensure that your cordless screwdrivers are on the calibration list of special equipment that need monitoring. The aircraft fasteners torque requirements are those found in the respective aircraft maintenance manual. The calibration process may be obtained by contacting organizations that offer such services and that are recognized by an international body such as the American Society for Testing and Materials (ASTM International). Don't screw up your work and your life too!

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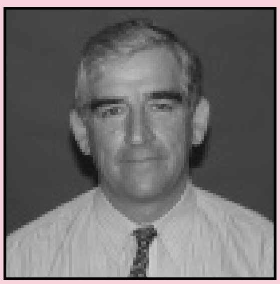

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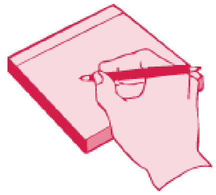
Letter to the editor



Ref: Turbomeca Arriel 1 Engine Bearing Failure Due to Contamination: There is no physical way (aside from dismantling the engine), to ensure that the inner walls of the gas generator shaft section are free from dust accumulation. Even if one were to decrease the time interval between each vibration monitoring, and axial compressor measurements, and unless any reading is beyond those prescribed, it is impossible to determine the state of the dust accumulation inside the shaft. This is what most engineers are finding. The above action, as stated in your article, while providing strict adherence to the Service Bulletin (SB) and Airworthiness Directive (AD) may not provide the assurance that you seem to offer. While all of this may seem well, if a section of accumulated dust, let's say, 100 g suddenly falls off of its own accord, and an incident/accident or worse occurs, the approved maintenance organization (AMO) may very well be labelled as a maintenance organization that doesn't strictly adhere to the AD and manufacturer requirements. The broad brushing that your article employs doesn't help the situation. The engine seemed to be designed in such a way that it should be considered mandatory that it be fitted with an air filter that will prevent the natural accumulation of dust in the shaft area. For operations in Canada, there is a requirement for two different types of filter. One is for use in snow conditions and the other for areas where dust is present. Fortunately, the filters do not seem to lower the output of the engine. Most engineers are keenly aware of their responsibility and go to great lengths to ensure that the requirements are met and that the operation meets the most stringent safety requirements. Engineers do not have control over the decision to purchase more equipment, such as an air filter, and the onus should be put back on company management as to the correct kind of equipment required to operate in a given environment.

Your statement that the risks remain, and only diligent application of the manufacturer's recommendations can ensure the continued airworthiness of this engine, is unfortunately not completely true, because in this case adherence to the published recommendations can cause a false sense of security, as there is no way of knowing, for sure, about the amount of accumulation of dust on the inner walls of the shaft, even after the engine is determined to be, airworthy.

Mr. Terry Eissfeldt, Port McNeill, British Columbia

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Mechanical Happenings

The following aircraft incidents are a heads-up for aircraft maintenance engineers (AME); they mainly focus on the maintenance outcome of the incident and do not include all of the circumstances of each flight. In most cases of component failures, it can be assumed that a service difficulty report (SDR) was submitted.

Aerospatiale AS350 B2 —The helicopter had lifted off after picking up a crew working a fire. The pilot noticed smoke entering the cabin, and checked the instruments, but no abnormal indications were noticed. As the smoke increased in intensity, the pilot realized that he could not return to the helipad, therefore, he called in an emergency to the firebase and landed on a pipeline-cleared area. After evacuating the passengers, the pilot found that a number of items in the right hand (RH) cargo compartment were burning, and removed the baggage while extinguishing the fire in the compartment. There were no injuries, but the helicopter was substantially damaged. Initiation of the fire appears to have been a damaged/ shorted fuse holder for the essential bus/engine Ng indication. The Transportation Safety Board of Canada (TSB) examined the helicopter and sent the fuse holder to the TSB lab. They are researching previous chafing and/or shorting that might have been recorded in the aircraft's records. They are interested in some other conditions that may have caused the short other than "baggage contact" (i.e. that it had been broken and shorted). A pair of blue jeans is thought to have spread the fire. Two writing pens melted and had bonded to the fuse cap. The TSB reports that the operator is looking into why the fuse holder was mounted under the battery, as it was to have been mounted vertically above the battery.

Airbus A300F4 —In April 2003, the crew declared an emergency due to smoke in the cockpit during the take-off climb-out from the airport. The scheduled domestic cargo airplane was not damaged. The captain indicated that during climb out he and the first officer smelled an acrid smoke followed immediately by the illumination of the main deck cargo fire light, as well as the audio tone (bell). They conducted the emergency procedures, declared an emergency, and turned back to land. While on the downwind leg, the main deck cargo fire lights went out. However, on final, the mid 2 loops A and B re-illuminated. No discrepancies were noted with the landing. The captain stated that after landing, the flight crew carried out the ground emergency evacuation procedures. He indicated that when they attempted to automatically and manually activate the R-1 door slide it did not inflate. The first officer indicated that during the evacuation he deployed the door at R-1. The door opened; however, the emergency slide did not inflate. Automatic and manual attempts to deploy the slide were unsuccessful. The first officer further stated that he and maintenance personnel checked the door during the pre-flight. According to the company, the smoke was attributed to oil and another fluid, possibly glycol, contamination of the air-conditioning packs. Maintenance personnel found the No. 1 and No. 2 water coalescer separator bags covered in a dark fluid. They replaced the auxiliary power unit (APU) load compressor, along with the two water coalescer separator bags. The airplane was ground run with no discrepancies noted.

Bell 204B —The helicopter had departed on a smoke patrol in support of forest-fire-fighting operations. The helicopter was established in cruise flight at 3 000 ft when, approximately 15 to 20 min into the flight, a banging noise was heard coming from the tail area, followed by a slow and smooth 30° yaw to the left. The pilot gently applied opposite pedal and was able to correct the yaw. The banging was not repetitive, but was heard as pedal was applied. The pilot landed the helicopter straight ahead in a swampy area. The helicopter landed without incurring further damage or injury to the occupants. An examination of the helicopter revealed that one of the tail rotor pitch link bolts (AN 174-15 or subsequent) was missing and that the pitch link was hanging free from the tail rotor horn, but still attached on the opposite end to the crosshead assembly. One, or both, of the tail rotors had struck the tail boom several times in flight causing the banging noise to be heard by the pilot and damage to the tail boom. The tail boom and tail rotor assembly is to be replaced in situ, but it could have been much worse.

Bell 206B —The helicopter was approximately 1 000 ft above ground, on a reconnaissance flight over a forest fire in Alberta, when the engine (Allison 250-C20) decelerated to minimum idle speed. A forced landing was conducted onto a muskeg area adjacent to the fire, and on touchdown the main rotor struck and severed the tail boom. The pilot and passenger were uninjured. The field investigation discovered that the compressor pressure (Pc) line from the engine governor to the fuel control unit had separated.

Boeing 757 —The passenger jet was at a cruise altitude of 37 000 ft mean sea level (MSL) when a flight attendant called from the aft cabin and stated there was a fire in the left aft lavatory, and that another flight attendant was fighting the active flames with a Halon extinguisher. The captain declared an emergency, requested priority handling for landing at Salt Lake City, Utah (SLC), and made an uneventful landing. An examination of the airplane revealed the lavatory toilet water level sensor was charred and melted. On further examination, the top left corner of the circuit board in the sensor was melted and consumed. Portions of several wires that had solder attachments to the circuit board at the melted area, including a 115-volt AC input wire and a 28-volt DC ground wire were melted. The left side of the circuit relay, adjacent to the consumed area of the circuit board, was melted and had melted solder on its exterior. The left hexagon-shaped screw, one of the two screws that mount the relay to the circuit board, was also melted. The manufacturer determined the melting point of the screw was between 2 550°F and 2 650°F. The investigation team determined that for these temperatures to occur, one of the wires in the area of the left screw would have had to arc.

Grumman G-V —Shortly after departure, the pilot requested a return for landing because the landing gear would not retract. As the jet flared for landing and the crew pulled the power levers back to idle, the spoilers deployed because of a disabled weight-on-wheels (WOW) switch. Maintenance personnel had failed to remove tongue depressors that were used to disable the WOW switch of a Gulfstream V on jacks. That practice led to a hard landing causing substantial damage to the airplane. Tongue depressors are used by mechanics on certain aircraft because they are a convenient way to check out some ground-air sensed items, such as windshield heat, which is necessarily inoperative on the ground. Pitot, angle of attack and static port heat are others. But, as can be seen from the summary, tongue depressors can produce complications and eventually someone pays the price—especially when such undocumented maintenance measures become the norm. Flight data recorder information showed that the spoilers deployed when the airplane was nearly 60 ft above the deck. The airplane thumped onto the runway with a force of 4.25 G, driving the right main landing gear through the wing and rupturing a fuel tank. "While changing tires, maintenance technicians placed the aircraft on jacks, and avionics personnel took advantage of this opportunity to perform tests on the electronic system. In order to perform the tests, [they] used tongue depressors to hold the landing gear switch in the on-ground position. This procedure is commonly used for testing purposes to override the actual position of the landing gear. When the electronic tests were complete, the avionics personnel forgot to remove the tongue depressors from the gear switch." Lesson: If tongue depressors are used to disable the WOW switch, be sure to remove them before flight. Flagging such items is a time-honoured method of avoiding embarrassment. The larger the dayglo flag, the less likely the gaffe. Cost of tongue depressors: $0.40, cost of a G-V: $40 million

Sikorsky S-61A —In January 2003, the helicopter was substantially damaged when it impacted terrain during a forced landing. Both pilots sustained serious injuries. According to the crew, after the helicopter came out of maintenance, the captain and first officer conducted a test flight, and then ferried the helicopter to the logging area. On the day of the accident, the first officer flew flights one and three, and the captain flew flights two and four. Each flight lasted about 1 hr 20 min, the helicopter was not refuelled between flights, and the flying pilot would occupy the left seat. During the previous flights, no flight control anomalies were identified, and on the accident flight, the captain was in the left seat and flying the helicopter. After completing approximately the seventh load of the flight, the captain manoeuvred the helicopter over the ground tenders, and entered a 155-ft out-of-ground-effect hover. The tenders connected the chokers to the cargo hook, and called "clear." About the same time, the helicopter started a slow uncommanded yaw to the right. The captain applied full left pedal, released the load, and the ground tenders called "kick out." With full left pedal applied, the helicopter continued to yaw right. During the first revolutions, the captain identified a small clear area to the north. The area was approximately level with the helicopter, and approximately 150 ft away on a ridgeline. The captain tried to manoeuvre the helicopter to the clear area, but by the fourth revolution, the yaw rate had increased drastically, and helicopter controllability became a major issue. The first officer placed his left hand on the throttles, and the captain called for engines to idle. The captain entered an autorotation, and applied full collective before entering the trees. The helicopter impacted the ground, came to rest up right, and both pilots exited with the assistance of one of the ground tenders. The crew estimated they had conducted 75 loads on the day of the accident. In addition, the first officer estimated the winds were approximately 270° at 10 kt. Examination of the tail rotor flight control system revealed that the left tail rotor control cable was broken. The break was in the aft part of the cabin and associated with a pulley assembly. The cable break revealed that some of the cable strands were bent rearward, and deformed. The cable fracture surfaces seen under a stereomicroscope revealed that some of the fractures were irregular and deformed. Examination of the associated keeper pins under a stereomicroscope revealed that both pins displayed wear marks, and light scratches consistent with control cable contact. The associated pulley was intact. The maintenance records revealed the helicopter had undergone extensive repairs before being returned to service in January 2003. While in maintenance, both tail rotor cables were removed and then reinstalled. At the time of the accident, the helicopter had flown 5.3 hr since returning to service, and total flight time was 14 603 hr.

Certificate of Responsibility

by John Goglia, member of the National Transportation Safety Board (NTSB) with 30 years experience as an AME

Do you remember how proud you were when you finally passed all the requirements for your *Airframe and Powerplant Certificate*? I can still remember the feeling of accomplishment I had when I was told at the end of my practical test that I had passed. I was finally ready to use my newfound knowledge to follow a dream in aviation and to earn a living. In those days, the financial rewards were not impressive, but the love of aviation surpassed the reality of the pay rates.

I also remember the endless times that our instructors pounded into our heads the fact that our certificates carried with them a considerable burden. Our certificates are issued by the government because we have demonstrated a level of competency, in both mental ability and the ability to translate that into the accomplishment of repairs to aircraft or the components that make up an aircraft. Broadly stated, we have been granted a degree of public trust in that we will use our brains and our physical abilities to follow the proper processes in insuring the aircraft we work on are repaired properly.

The dictionary defines the word *responsible* as, "being legally or ethically accountable for the care of another," also, "involving personal accountability or ability to act free from guidance or higher authority," and finally, "capable of making moral or rational decisions on one's own, thereby being answerable for one's behavior." We are not the only professionals who are held responsible for our actions as individuals. Doctors, attorneys, and certified public accountants, to name a few, are also held accountable for their actions. They also hold a form of certificate issued from some official body, which grants them special privileges based on a measurement of mental and physical ability. They are also held accountable with not only action against their certificates, but they may also face civil and criminal charges. As part of my responsibilities as an NTSB member, I review and formally vote on the appeals of certificate holders that the Federal Aviation Administration (FAA) has found its actions warrant enforcement action. It is surprising to see the number of mechanics who have found themselves in the enforcement process and even more revealing to look at the reasons why.

A considerable portion of our training is focused on processes that include understanding what we are faced with, thinking through the problem and applying our good judgment within the confines of the appropriate manual. Remember, we receive our authority to perform maintenance from the manuals and it is difficult [but not impossible] to get into trouble when we follow the manual. Are we following the manual when we ask for and receive verbal instructions from a co-worker? Many times in my career, I have followed instructions from a maintenance control person who is located miles away and whose job it is to provide such information in an effort to expedite repairs. I recall only once asking for the manual reference for the guidance I received. If these instructions are wrong, who carries the responsibility?

The answer is the person who signs for the accomplishment of that task—no ifs, ands, or buts—the person who signs for the task is responsible and will be held so for the satisfactory completion of that task. This holds true if the guidance comes from the person working next to you, or from your supervisor or manager. When you sign your name for accomplishing a task, you are saying that you followed all the appropriate provisions in accomplishing this task. Even if that guidance is wrong, you will still be held responsible.

There is another area that we must pay close attention to, and that is in preparing the paperwork for signing. I have prepared paperwork for a large number of mechanics who worked for and with me, and I do not believe I ever put them in harm's way with the paperwork I created, but that may not hold true for others who have performed the same function. If you allow someone else to prepare the paperwork for your signature you need to review it carefully to ensure that it accurately reflects the work that was accomplished. Our responsibility to maintain accurate records is clearly spelled out in the *Federal Aviation Regulations* (FARs)[1] and can result in an additional violation when things go wrong.

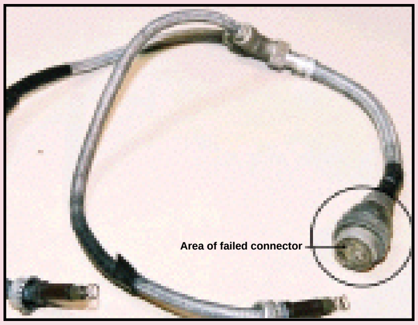
I am writing about our responsibility and the process that maintenance uses to ensure a safe air transportation system because I often have to review maintenance cases, which have as the core charge a failure to follow the very basic process outlined above. As I review some of these cases, I am forced to just pause in disbelief at the number of otherwise good mechanics who will have their certificate blemished for ignoring the basics.

Every task we accomplish must be considered as critical. Although the role of the passenger entertainment system in the SwissAir accident is not clear, the fact that it possibly could have been involved makes the point that there is no task that is unimportant. Everything we do must be accomplished to the highest standards. I realize that there are pressures we put on ourselves and that are put upon us, but we cannot allow even the smallest task to be accomplished in a substandard manner—and that includes all the paperwork.

Responsibility is what separates a certified aircraft mechanic from a plumber or a plasterer. There are many careers in our society that require knowledge and ability to accomplish, but when you add the public trust and the individual responsibility, the list becomes much shorter. We must never lose sight of our responsibility.

[1] The U.S. equivalent to the *Canadian Aviation Regulations* (CARs).

DeHavilland Beaver and Otter: Potential for Premature Magneto Failure



A float-equipped DHC-2 was cruising at an altitude of 1 500 ft enroute from Campbell River, B.C. when the engine failed and would not restart. The pilot set the aircraft up for a glide and proceeded to land uneventfully close to a marina near Seymour Narrows, B.C. The aircraft was soon towed to a safe moorage where the pilot and passengers were able to exit the plane and return home. Close examination of the engine revealed that the engine stoppage was due to a failure of the dual magneto cable connector lug at the firewall. This part, identified as SKL3-21-3-8AN, has an internal safety mechanism that disables both magnetos to preclude inadvertent start of the engine when the magneto electrical harness is disconnected from the firewall for maintenance.

When the unit functions properly and the lug is connected, a male mating pin lifts a shorting strap out of the way and removes the ground from the magneto "P" leads, allowing control of the magnetos through the cockpit magneto selector switch. If this pin fails, it may allow the shorting strap to ground the mags and the engine malfunctions. This type of connector receptacle only seems to be common to the DHC-2 and -3. The connector is an "on condition" component and as it ages, the risk for malfunction increases. There is no practical test to determine its condition. Aircraft maintenance engineers (AME) working on these types of aircraft may not be aware of the presence of such a mechanism and may find, through a continuity check that the magneto leads are all right when in fact, this grounding strap may be about to fail. The maintenance manuals for both of these aircraft as well as the Service Bulletin and Service Letter index make no mention of such unit maintenance requirements as they are operated to failure, then replaced.

In another similar case of engine failure, the Otter engine failed because the magneto connector lug at the firewall loosened and let go, allowing the internal connector grounding strap to function and stop the engine. Investigation revealed that the magneto connector lug secured by a lock wire had failed because the lug collar hole had broken open and allowed the lock wire to slip away and the connector to become undone. De Havilland Alert Service Letter A2/53 makes reference to this mode of failure and a check of the state of these important features on the connector lugs will prevent the reoccurrence of such mishaps. Bombardier/DeHavilland, recommends that this inspection be carried out at the earliest opportunity. Beware!

Bombardier Dash-8-400—Risk of Main Landing Gear Wheel Bearing Failure Caused by a Displaced Wheel Bearing Grease Seal

In January 2003, a Tyrolian Airlines DHC-8-402Q lost its No.3 main landing gear (MLG) wheel and tire assembly along with a section of the axle and axle nut while taxiing to the runway in Frankfurt, Germany. During taxi, the crew felt some light vibrations but they stopped after a period of approximately 10 seconds.

The inboard anti skid annunciator light illuminated and the crew contacted air traffic control (ATC) and ground support to review the event. As per the minimum equipment list (MEL), technical support and the crew decided to proceed with the dispatch of the aircraft. The aircraft took off and continued on safely to its destination, Salzburg, Austria. During the landing roll, ATC informed the crew that there were sparks in the area of the No. 2 MLG. The aircraft was escorted to the ramp where the loss of the wheel and tire assembly was observed following a brief inspection by the crew.

Preliminary investigation determined that the No.3 right-hand inboard axle had failed at the radius area of the threaded portion of the axle; located right off the outboard bearing seat. Time in service of the aircraft was 1 029 hrs and 1 181 cycles. The probable cause was cited as being a displaced outer bearing grease seal during installation. An inspection of the main wheel assembly was conducted and found that the outer bearing race was spalled, which indicated that it had been installed and had failed, causing the likely source of heat on the portion of the lower axle, adjacent to the overload damage.

A recent test performed on a Dash-8-400 MLG wheel installation revealed that if the outboard grease seal was allowed to drop off the bearing land and rest in the threaded relief between the wheel nut and the end of the axle land, it would allow the seal to be trapped between the nut and the axle journal land. This situation could easily occur each time the wheel assembly is replaced and go unnoticed as the nut is torqued. The nut compresses the outer seal against the land instead

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Tool Control

Tool control is more than just accounting for all of the tools that you normally find in your toolbox. In the last issue of the *Maintainer*, I mentioned that Transport Canada, System Safety had developed a tool management program, which is available on CD-ROM. The goal of this program is to assist you, the aircraft maintenance engineer (AME), in developing methods to improve the control of tools and part accessories in your workplace. Here is a short story that may seem familiar to some of you.

An AME was given the usual maintenance task on an airplane. He grabbed his toolbox, opened it and checked that he had all of the necessary tools. He then walked over to the aircraft and proceeded to do the work. When he finished, he returned the tools to his toolbox and gave them the once-over—to make sure that they were all there. But something caught his eye. There, at the bottom of his toolbox was a part that he hadn't seen before. A half-inch long cylindrical piece of metal, half an inch in diameter, with teeth marks on it as though it was part of an assembly. He re-examined all of his tools and they were all in order and were not missing any parts. He grabbed his toolbox, walked over to his supervisor's office and showed him the part. He, too, could not identify it and asked where it had come from. The AME replied that he had found it at the bottom of his toolbox when he did the inventory of his tools. The supervisor had him check all of his tools but they were all in perfect shape. The AME then decided to put the unidentified part in the desk drawer of the office and left. Looking back at this incident, we all know that screws, fasteners, safety wires and things like this unidentified part can, in the wrong place, constitute foreign object damage (FOD), even in a desk drawer.

Two weeks later, as the engineer was cleaning up the desk drawers, he picked up the little piece of steel that he had found and, as he had still not identified where it had come from, threw it in the trash bin.

About a week later, the AME was acting as night supervisor, and was responsible for all of the special tools in the tool shop. He reviewed all of the tools for the past three weeks but still, had not found any that were broken, worn or missing pieces. He then sent a young AME out to replace a component on an engine. As the young AME was putting in the new part, he dropped a bolt to the bottom of the engine compartment. He reached for the flexible magnet tool in his toolbox and noticed that it was missing the round magnetic end. He brought it over to the supervisor who immediately recognized that it was the unidentified part that he had thrown away in the trash bin three weeks earlier. In this case, the piece was accounted for, but had it not been found, it could have lodged somewhere and caused damage. FOD is dangerous and has been responsible for many in-flight emergencies. Flight controls and throttle quadrant jamming by FOD are some of the failures that have led to crashes and the loss of life.

Tool control is not just looking in a toolbox to make sure that all of your tools are there. It is making sure, by looking at each and every tool, that all of the tools and their respective component parts are there. You have to ensure that all of the pieces are secured; not worn, broken or missing! This makes good sense and will save you a lot of time looking for missing tools or tool parts or having to ground an aircraft in order to retrieve a missing part or tool. Always inventory your tools after a maintenance task—for safety and peace of mind!

CASS 2004—Time for a little T.O.!

The 16th annual Canadian Aviation Safety Seminar (CASS) will be held in beautiful Toronto, Ontario, April 19 to 21, 2004. CASS is an international event hosted annually by Transport Canada for all sectors of the aviation community. The theme for CASS 2004 is "The Future of Aviation Safety" which calls for nothing less than gazing into the crystal ball to get a sense of the safety issues the industry and regulatory authorities will face between now and the end of the decade. For information on how to register, visit http://www.tc.gc.ca/CASS. Time for a little T.O.!

Bombardier Dash-8-400—Risk of Main Landing Gear Wheel Bearing Failure Caused by a Displaced Wheel Bearing Grease Seal continued from page 7

of against the bearing race sidewall and the end result is that there is no load applied to the wheel bearing assembly. An insecure wheel bearing assembly will soon move about, overheat and eventually fail. It may occur very quickly. Bombardier issued Service Bulletin (SB) 84-32-26 dated February 12, 2003, which reviews the process.

Furthermore, Bombardier requests your assistance for any ideas that might improve the safety aspect, short or long term, of this operation. So the next time you are asked to replace an MLG wheel assembly on the Dash-8, review the latest revision to the aircraft maintenance manual (AMM), the applicable SBs and proceed with care.