National Defence
Défense nationale

# Flight Comment

ISSUE 2, 2015

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Canada

Cover – Master Corporal Donovan Ball, a Search and Rescue Technician supervises the transfer of a simulated patient from a CH-149 *Cormorant* helicopter with the assistance of Corporal Noemie Lavigne, Medical Technician, and Corporal Jason Kennedy, a flight engineer during the 2013 National Search and Rescue Exercise in Gimli, Manitoba, on September 18, 2013.

Photo: Sgt Bill McLeod, 17 Wing Winnipeg











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**THE CANADIAN ARMED FORCES FLIGHT SAFETY MAGAZINE**

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SÉCURITÉ DES VOLS FLIGHT SAFETY


ISSN 0015-3702 A-JS-000-006/JP-000


# Views on Flight Safety

by Colonel Pierre Morissette, Royal Canadian Air Force Surgeon

Colonel Pierre Morissette currently holds the position of Royal Canadian Air Force Surgeon in Ottawa, ON. As such, his current responsibilities include advising the Commander of the RCAF on all medical matters and advising the Surgeon General of the CAF on all matters relating to the RCAF and to aerospace medicine. By virtue of his position, Col Morissette is also designated as Aerospace Medical Authority for the CAF and acts as Canadian Head of Delegation for the NATO and Air and Space Interoperability Council Aerospace Medicine Working Groups.

As the Royal Canadian Air Force (RCAF) Surgeon and the Aeromedical Authority, it is a pleasure to introduce this Aeromedical edition of the *Flight Comment* magazine. The Health Services are proud to support Aerospace Operations in the Canadian Armed Forces (CAF) by keeping its most valuable and expensive assets – its people – healthy and "fit to fly." Our job is to keep people on the line and in the air, fulfilling the mission.

Flight Safety is at the heart of what we do, and it has never been a more exciting time to be part of the Flight Safety Team.

### The times are changing…

It is a remarkable point in history for aviation throughout the CAF. The RCAF, the home of airpower, is moving into a new era of capabilities and responsibilities. At this moment, the RCAF is distinguishing itself by leading two major simultaneous international operations. New aircraft, such as the CC130J *Hercules*, CH147F *Chinook* and CC117 *Globemaster*, have joined the fleet. The CH148 *Cyclone* and a CF188-replacement fighter are just over the horizon. Older aircraft, such as the CP140 *Aurora*, revitalized with new equipment, are working in new environments and taking on unprecedented roles.

At the same time, the Canadian Army (CA) and the Royal Canadian Navy (RCN) are joining the world of Aerospace Operations. With the expansion of UAV capabilities operated by their own personnel, the CA and the RCN are poised to play new roles in exploiting "the high ground."

These aircraft, performing at greater extremes of the performance envelope and higher Op Tempo, are already bringing new aeromedical challenges. The Health Services will be working harder than ever to keep the humans working on them safe and performing at their peak.

### But some things never change…

Still, even as technology and missions evolve, the humans taking part do not change. In this regard, the basic role of the Health Services in supporting our personnel and promoting safe flying operations remain the same. We remain committed to providing high-quality health care, to keep our aviators in the air. We remain committed to fostering a robust Flight Safety Culture and helping it take root within the CA and RCN, as they expand their own aerospace capabilities. We remain committed to applying the latest science and research to preserving or even expanding the human performance envelopes of our flying personnel, in every domain from fatigue to psychological resilience. Finally, we remain committed to engaging with the aerospace operators to build trust, so that they can be confident that our job is to keep them flying.

With the RCAF in the lead, and the Army and RCN joining the fight, Aerospace Operations are poised to be more important than ever within the CAF. The Health Services are pleased to be part of the team that enables mission success through Flight Safety in this time of unprecedented change. I hope this Aeromedical edition of the *Flight Comment* magazine provides a window into some of the issues facing the aerospace community and the work the Health Services are doing to resolve them.

Mission first. Flight Safety always.

# The Editor's Corner

Canadian Armed Forces Health Services personnel are an integral part in military aviation. Contrary to what many believe the medical community's duty is not to find ways to ground you, but rather to find ways to ensure you keep flying at your best. From basic clinical support, to preventive health medicine to research and development, health services personnel play an active role in promoting safe flying operations every step of the way.

In this medical-centric issue of *Flight Comment* magazine, we have invited numerous physicians to give us their perspective on Flight Safety within their elements including other informative topics such as G-induced loss of consciousness and presbyopia to name a few.

In the *From the Flight Surgeon* article, Major Tyler Brooks will bring you up to speed on medical-related Flight Safety issues following a conference he recently participated in back in November.

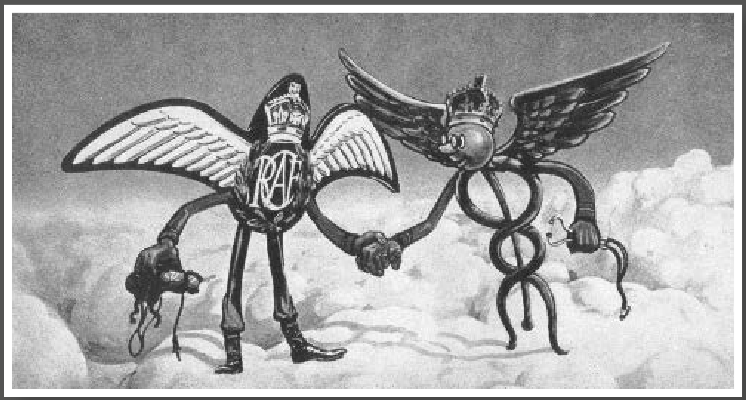
In a special edition to our *Check Six* section, we take a look back at the forerunners of aviation medicine in Canada. Beginning with this issue and throughout the next two, we'll visit the numerous advances in medical safety in aviation and the people who pioneered them.

A special thanks goes out to our resident flight surgeon, Maj Tyler Brooks, for his effort in garnering support from all the contributors for this issue.

Finally, I wish you all a safe and fantastic summer and I'll see you back here with the next edition of *Flight Comment* in the Fall.

*Sic Itur Ad Astra*
*Sanitas*

**Major Peter Butzphal**



# Good Show

## For Excellence in Flight Safety

## Master Corporal Carl Coney

On 7 May 2013, while observing the aircrew of a CT114 *Tutor* conduct a pre-flight brief, MCpl Coney of the Aerospace Engineering and Test Establishment (AETE) unit in Cold Lake noticed a critical portion of the emergency oxygen connector was missing on one of their parachutes. He immediately informed the pilot of the situation and rendered the chute unserviceable. While the connection between the pilot and the oxygen bottle could still be made without this tiny part, it would be impossible to supply oxygen to the mask in an emergency.

Further demonstrating his dedication to the flight safety program, MCpl Coney wrote up all *Tutor* aircraft that the parachute had been used in as unserviceable in order to carry out extensive foreign object debris checks. Recalling a similar incident that had happened years before, he was able to narrow his search to the canopy section of the aircraft. Within an hour he was able to find the rogue part and remove it from the aircraft ensuring that AETE's CT114 fleet was safe to fly.

MCpl Coney's attention to detail and outstanding expertise averted a potentially deadly situation, making him well deserving of a Good Show Award.


Photo: DND

# Good Show

## For Excellence in Flight Safety

## Corporals Aaron Kennedy and Byron Plume

On 9 May 2014, while coordinating armament snags and loading operations on CF188 *Hornet* aircraft, Cpls Aaron Kennedy and Byron Plume, air weapons systems technicians at 409 Tactical Fighter Squadron identified and halted a dangerous maintenance action being carried out by a team of technicians on an adjacent aircraft. They noticed that aviator's breathing oxygen was connected to the aircraft in an area which they found unusual. As they were the only authorized Level A release technicians for aircraft oxygen systems available at the time they took charge of the situation. They discovered the technicians were troubleshooting a throttle boost snag on which they had mistakenly identified aviator's breathing oxygen as nitrogen and used it to run tests on the Environmental Control System (ECS). Although the bottles are colour-coded green for aviation oxygen and grey for nitrogen, the fittings on the test equipment are identical for testing purposes.

They immediately directed the aviation technicians to cease testing and removed the oxygen line from the aircraft. If this situation had been allowed to continue, aviator's oxygen would have been purged through the ECS introducing it to a grease/oil contaminated compartment and thereby creating the potential for an uncontrollable fire hazard on a fully fuelled aircraft.

As a result of this incident, the unit has implemented covers for all oxygen related testing equipment, identifying them as to be used on oxygen system only, and have secured these items in a cage which limits access to Aviation Life Support Equipment personnel only. A Technical Awareness Bulletin was also produced from this incident, identifying the differences between oxygen and nitrogen bottles.

The situational awareness and quick actions of Cpls Kennedy and Plume prevented a potentially serious aircraft incident and possible loss of life. Their outstanding professionalism and superior technical knowledge make them well deserving of this Good Show Award.


Photo: DND

# For Professionalism

For commendable performance in flight safety

## Captain Daniel Caron

During a regular pre-flight inspection on 15 July 2014, Capt Daniel Caron, a pilot with 430 Squadron in Valcartier, noticed that four shock struts on the main rotor of a CH146 *Griffon* helicopter appeared to be poorly installed.

The aircraft had just undergone a 3000 hour inspection, and even though the pilot who had done the inspection had declared the helicopter fit to fly, a more meticulous inspection by Capt Caron determined that the shock struts had been poorly assembled. Several of the connecting sleeves had been installed on the wrong side of the shock struts, contrary to the current Canadian Armed Forces Technical Instructions. According to the pre-flight checklist, the pilot is required to verify the overall condition of the aircraft but does not have to examine the shock struts of the main rotor. Moreover, the pilot publications contain no links to the directives governing the shock strut assembly in question.

Thanks to his profound knowledge of aircraft systems, Capt Daniel Caron may have prevented an accident. The attention to detail and professionalism that he demonstrated, along with his constant focus on flight safety, undoubtedly make him worthy of the For Professionalism Award.

Photo: DND

## Sergeant Nathalie Rhéaume

Photo: MCpl Déri Langevin

Sergeant Rhéaume is an aerospace control operator at Canadian Armed Forces Base Valcartier. While reviewing the 1 Canadian Air Division Ramp Defensive Driving Course (RDDC), she found a major error in the codes for signals and light colours used by Air Traffic Control (ATC) agencies to authorize airfield movements.

The RDDC is used to train all military aerospace personnel on safety measures for the movement of vehicles, personnel and equipment at airports and heliports. The presentation on driving on aprons at airports and heliports was not consistent with the ATC Manual of Operations 317.3. The RDDC that is given nationally had a critical error which could have led to a very dangerous situation if personnel operating a vehicle, moving equipment or walking entered a takeoff or landing zone believing that they were

*Continued on next page*

## Master Corporal Nicholas Mann

During an audit on a CH146 *Griffon* main rotor yoke Special Inspection (SI) dating back to 1998, MCpl Mann, an Aviation Systems technician employed with 400 Tactical Helicopter Squadron found a major maintenance discrepancy.

While studying the SI to become familiar with its contents, he determined that one of the yokes on the aircraft did not have a 500-hour life penalty applied as the SI dictated. He then exercised heightened diligence and checked the remainder of the squadron's aircraft. He found a similar issue with other aircraft, however in this case the aircraft had over flown the retirement life once the penalty was applied. The aircraft was immediately placed unserviceable as the yoke was critical to the safety of flight. MCpl Mann went on to check other squadrons and found additional aircraft with the same issues. This information was passed on to the Aircraft Engineering Officer in Ottawa which resulted in a fleet wide SI to check the life data on all yokes of the *Griffon* fleet.

MCpl Mann's meticulous attention to detail and work ethic likely saved the lives of aircrew and preserved aviation resources since there was a high probability of a failure of this flight critical component when airborne. MCpl Mann demonstrated the kind of professionalism upon which a sound Flight Safety Program is built and makes him most deserving of a For Professionalism award.


Photo: Sgt Kev Paule

### *Sergeant Nathalie Rhéaume ... Continued*

authorized to do so as a result of incorrectly interpreting the light signals guiding aircraft both on the ground and in the air.

Sgt Rhéaume displayed professionalism of the highest order by taking measure to correct these previously undetected lesson plan errors. Her attention to detail is commendable and her outstanding professionalism and work ethic averted the potential for a significant airfield incident or accident. Sgt Rhéaume is very deserving of this For Professionalism award.

# For Professionalism

For commendable performance in flight safety

## Corporal Jean-Pierre Dionne

On 16 September 2014, Cpl Jean-Pierre Dionne, a 442 Squadron Flight Engineer (FE), was introducing a new FE to the exterior portion of a pre-flight check on the CC115 *Buffalo*. In addition to the required condition/security check of the propeller assembly, Cpl Dionne demonstrated how to check for excessive forward and aft movement in the propeller blade. During this check, he noticed highly unusual and extreme play in the propeller blade as well as play in the entire propeller assembly. Cpl Dionne also detected a significant gap between the propeller assembly and the engine nacelle. It was later determined that the entire propeller assembly was loose on the engine's torque shaft.

A further detailed investigation by Cpl Dionne revealed that the aircraft had flown six point nine hours since the propeller was installed. This condition had gone unobserved during multiple servicing checks and pre-flight inspections; checks that were carried out by various air and ground crew personnel. Had the aircraft continued to fly in this condition, it is entirely possible that the propeller assembly would have failed or worse, separated in flight, causing a total loss of aircraft control, and possible loss of life.

Cpl Dionne's initiative and professionalism in demonstrating the excessive play check above the requirements of the pre-flight check to a new FE was instrumental in preventing the loss of the propeller and possible accident. Cpl Dionne exhibited outstanding commitment towards airworthiness and is most worthy of this For Professionalism Award.


Photo: DND

## Corporal Jeff Nichols


Photo: DND

On 17 March 2014 Cpl Nichols, an Aviation Technician at 5 Wing Goose Bay, was carrying out a routine Health Usage Monitoring System analysis on a CH146 *Griffon* helicopter when he noticed an unusual vibration trend emanating from the vertical fin sensors.

On his own initiative, Cpl Nichols promptly conducted an investigation to determine the cause of the vibrations. A thorough visual inspection of the external surfaces of the vertical fin identified several blackened rivets known as "working rivets," a typical indication of loose rivets. Exceeding inspection requirements, Cpl Nichols employed a borescope to conduct an exhaustive internal inspection of the vertical fin, the results of which showed a rivet that did not engage the corresponding bulkhead and three additional rivets that were incorrectly installed.

*Continued on next page*

## Corporal Lucas Powell

On 30 April 2014, Cpl Powell was performing a weekly runway inspection of El Gorah, Egypt airport (Operation CALUMET). While inspecting runway 08/26, Cpl Powell was directed by the duty flight follower, to stop the airfield inspection and proceed to standby position Orange, as a Casa C295 aircraft was preparing to land on Runway 26. From position Orange, most of the runway is not visible, but Cpl Powell took it upon himself to look for hazards to the approaching aircraft, notwithstanding the 6 other vehicles that were tasked with keeping the runways clear.

Some three hundred metres from his position, Cpl Powell noticed a local Bedouin man run across the runway to the crash response vehicles and indicate that he wanted water. Upon receiving the bottled water from the fire crew, the man started running towards the runway in the direction he had come from. The Casa aircraft was now on final approach and within two minutes of landing. Unexpectedly, the man stopped at the edge and casually strolled across runway. Cpl Powell immediately relayed to the flight follower that there was a man on the runway and that the situation was unsafe. This message was quickly passed to the pilot who commenced a go-around.

The runway clearing and security operation during an arrival or departure of Multi-National Force and Observers (MFO) assets are delegated to the fire hall, force military police unit, quick reaction force and north camp response teams, as the flight follower's tower is over one kilometre from the runway. All were present on the airfield at the time, but only Cpl Powell identified the danger. Through this incident, new runway inspection procedures were developed and guidance provided to all units involved in MFO airfield operations.


Photo: DND

Cpl Powell's professionalism, vigilance, and quick thinking resulted in the safe landing of the aircraft, and led to procedural changes, increasing safety for all on the airfield. Cpl Powell's actions make him very deserving of this For Professionalism award.

### *Corporal Jeff Nichols ... Continued*

Consequently, the skin was removed from the vertical fin revealing that improperly sized rivets had been used during installation, resulting in the skin being partially uncoupled from the bulkheads. It was also found that one bulkhead was warped and a second was much more pliable and weaker than the rest. This situation resulted in a degradation of the structural integrity of the vertical fin which supports both the weight and heavy aerodynamic forces produced by the tail rotor in flight. Several inspections of this area had been carried out since the last repair without detecting the condition and as a result of these findings the rest of the Wing's Griffons were inspected.

With the structural integrity of the fin compromised, it is unknown for how long it would have continued to support the flight loads imposed on it, potentially resulting in the catastrophic loss of the aircraft. Cpl Nichols' discovery and subsequent self-driven actions quite possibly prevented the loss of both life and aircraft. His determination, professionalism and outstanding due diligence make him a deserving recipient of the For Professionalism award.

From the

# Flight Surgeon

# Health Services Perspectives on Flight Safety

**by Major Tyler Brooks, Medical Advisor, Directorate of Flight Safety, Ottawa**

Have you ever wondered what your Flight Surgeon, your Dental Officer, or the Clinic Commanding Officer at your base thinks about Flight Safety? Wonder no more!

On 6 November 2014, at the Carling Campus in Ottawa, a group of Flight Surgeons, Dental Officers and Health Services Officers held a round-table discussion on Flight Safety. This conversation was part of the Clinical Leadership and Proficiency Training activity held annually by the Canadian Armed Forces Health Services.

Health Services (HS) personnel who are passionate about flying operations shared their views on a number of medically-related Flight Safety issues. Here is a summary of what they had to say.

1. **Ground Crew.** Much of the Flight Safety culture tends to focus on aircrew. However, HS personnel recognize that the health and well-being of ground crew is also vital to maintaining Flight Safety. Please let your HS providers know if you are involved in flying operations, especially if you have any concerns.

2. **Fatigue.** The management of fatigue on flying operations, both in aircrew and ground crew, remains an important concern. Emphasizing proper "crew sleep" (as opposed to just "crew rest") and the application of "fatigue science" to scheduling are important tools in avoiding fatigue. Caffeine gum will soon be available through the HS system to promote alertness, but the focus must remain on the only certain cure for fatigue: good sleep!

3. **Substances Hazardous to Aviation.** Alcohol, illicit drugs, prescription medications, and even over-the-counter remedies can all affect Flight Safety. Marijuana use is of particular concern since it is one of the most commonly used illicit substances and has long-lasting effects on performance. In 2012, the reported marijuana usage rate was 10.2% in the Canadian general population (15+ years old) and 20.3% for youth (15-24 years old).[1] In 2009, the Canadian Armed Forces (CAF) rate of marijuana use was found to be 3.7% through drug testing.[2] Clearly, any substance that impairs performance, including marijuana, is a hazard to Flight Safety. Personnel involved in flight operations must be aware of the risks of substances hazardous to aviation and discourage a culture of tolerance to substance use. Personnel worried about how substances may be affecting them are encouraged to discuss their concerns confidentially with their HS providers.

4. **Building Trust.** Medical personnel are still perceived as being responsible for "grounding" aircrew, rather than "keeping them fit to fly." Regular HS provider interaction, particularly by Flight Surgeons, with flying operations personnel is an indispensable strategy for breaking down this "trust barrier." The HS community must promote itself as being "the good guy," especially to aircrew...

5. **High Operational Tempo.** Flying units are always busy. However, right now the RCAF is leading two major international operations, placing high demands on all personnel involved. Sudden surges in operational tempo cause stress, which can be a hazard to Flight Safety. Unfortunately, important stress-mitigating activities, such as physical training, are often the first to be abandoned when the operational tempo increases. Vital stress management activities must be preserved as much as possible, and personnel are encouraged to speak with their HS providers if they have concerns.

6. **Closing the Loop.** HS personnel are an important part of your Flight Safety team. Their job is to help keep flight operations going smoothly and safely. When HS personnel are involved in Flight Safety decisions, please remember to keep them in the loop about the outcomes. This promotes good communication and helps HS personnel improve their decision-making processes. Don't forget, HS personnel like to know how things turn out, too!

What do you think? Do you have any concerns of your own or ideas for improvement? Feel free to send us your thoughts at dfs.dsv@forces.gc.ca.

Photo: DND

1. "Canadian Drug Summary April 2014." Canadian Centre on Substance Abuse accessed on 20 Feb 2015 at http://www.ccsa.ca/Resource%20Library/CCSA-Canadian-Drug-Summary-Cannabis-2014-en.pdf

2. Pan-CF Blind Drug Testing 2009, Results, Methodology, and Lessons Learned; Defence R&D Canada, Director General Military Personnel Research and Analysis, Chief Military Personnel, DGMPRA TM 2001-019, September 2011.

# Maintenance IN FOCUS

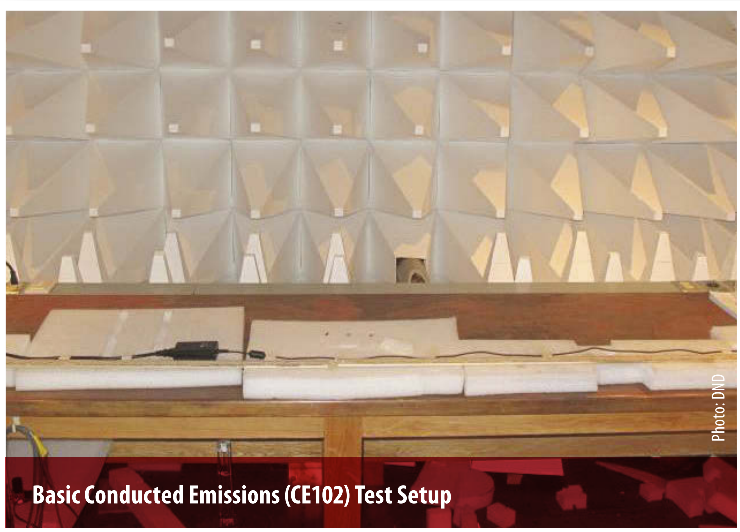
# CERTIFICATION PROCESS FOR AEROMEDICAL EVACUATION MEDICAL EQUIPMENT

**by Directorate Technical Airworthiness and Engineering Support**

Historically, clearance to use medical items onboard Canadian Armed Forces medevac aircraft was based on limited airworthiness testing that was focused on whether the device would pose an Electromagnetic Interference (EMI) threat to aircraft communications and navigation equipment. If the radiated emissions were within limits, as specified in Military Standard (MIL-STD) 461, the medical equipment was granted airworthiness clearance.

However, experience has shown that the use of medical equipment on aircraft presents a unique problem and a more robust airworthiness evaluation is needed. Items necessary to support a patient requiring air transportation may not be compatible with the aviation environment. Aircraft systems, particularly those emitting electrical signals, may cause errors in the functioning of medical equipment and could lead to improper diagnoses and treatments which may endanger the patient. Onboard medical equipment can also interfere with the aircraft systems and compromise the safety of the entire crew. In general, medical devices are designed to function in environmentally controlled locations, such as hospitals, and not in the harsh, dynamic aircraft environment.

In recognizing the importance of evaluating medical equipment, one must therefore consider both the airworthiness impact on the aircraft and crew, and the potential effects of the airborne environment on the proper functioning of the medical equipment, including any effects that could



Basic Conducted Emissions (CE102) Test Setup


Radiated Emissions (RE101) Test Setup


Y-Axis Random Broadband Jet Aircraft Vibration Test Setup

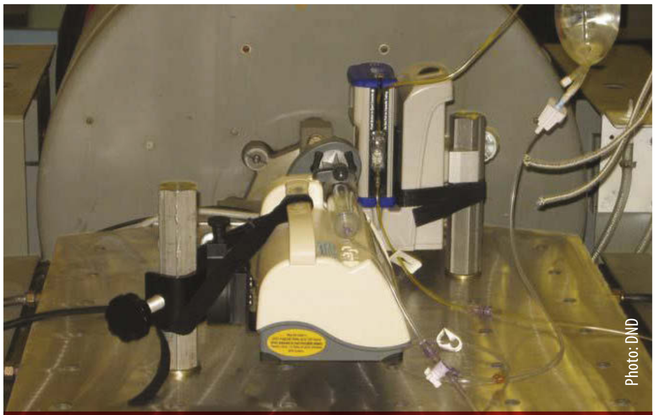
put the patient at risk. This is the cornerstone of the certification and qualification process for all new pieces of medical equipment being considered for use in the aeromedical evacuation (AE) arena. The Safe-to-Fly evaluation performed by Directorate Technical Airworthiness and Engineering Support (DTAES) specialists result in the airworthiness approval of equipment based on successful completion of environmental laboratory testing. In some cases, data substantiating approval is available by agreement from Allied nations. If the device has not previously been assessed for airworthiness, DTAES relies on the Quality Engineering Test Establishment (QETE) located in Gatineau, Québec, and the Aerospace Engineering Test Establishment (AETE) located at CFB Cold Lake, Alberta to effectively carry out testing.

Typical testing consists of the following:

- EMI testing determines if aircraft navigation and communication equipment is susceptible to electromagnetic emissions produced by the aeromedical evacuation equipment. Additionally, this testing determines if aeromedical devices are susceptible to fields generated by the aircraft equipment. The EMI conducted emissions (CE), conducted susceptibility, radiated emissions (RE), and radiated susceptibility tests are performed in accordance with MIL-STD-461. If there are anomalies observed during the radiated emissions testing performed by QETE, then the equipment is sent to AETE for an in-lab Electromagnetic Compatibility evaluation and tested to determine the likelihood of the emissions affecting aircraft communications and navigation systems, using the standards defined in MIL-STD-464.
- Airborne environmental testing subjects the medical equipment to extremes of temperature and humidity, vibration, altitude effects, rapid decompression and explosive atmosphere. These tests are performed in accordance with MIL-STD-810.
- Other factors considered during the certification process, often assessed by analysis, include electrical safety (notably the load placed on the aircraft electrical system, and the airworthiness of certain battery types), cabin safety (e.g. crashworthiness) and human factors.

Items not meeting airworthiness certification criteria may otherwise be approved for flight based on a risk assessment performed by the fleet Weapon System Manager/Senior Design Engineer (WSM/SDE) and/or the Air Division Surgeon, with input from laboratory engineers and DTAES subject matter experts. The objective of this assessment is to identify, quantify and mitigate the safety concerns noted during laboratory tests. The risk assessment categorizes each safety concern for potential risks to the aircraft, crew or patient, and provides suggested corrective actions or risk mitigation activities.

Recently, in October 2014, DTAES engineering specialists provided support to the CC177 *Globemaster III* WSM/SDE approval of an AE capability for patients requiring isolation and transport back to Canada following exposure to the Ebola Virus Disease. This interim capability employs an ambulance as an isolation chamber, secured in the cargo compartment of a CC177.




**X-Axis Random Broadband Jet Aircraft Vibration Test Setup**


**Test Setup Typical of Climatic Tests for Medical Equipment**


**Typical Vibration Test Setup. Shown for Vertical Axis Testing**



# PART 1

# Canada's Aviation Medicine Pioneers

**By Lydia Dotto**
**Reproduced and modified with permission from the Canadian Space Agency.**

## The RCAF Institute of Aviation Medicine

It was a job that gave new meaning to the phrase "knock yourself out."

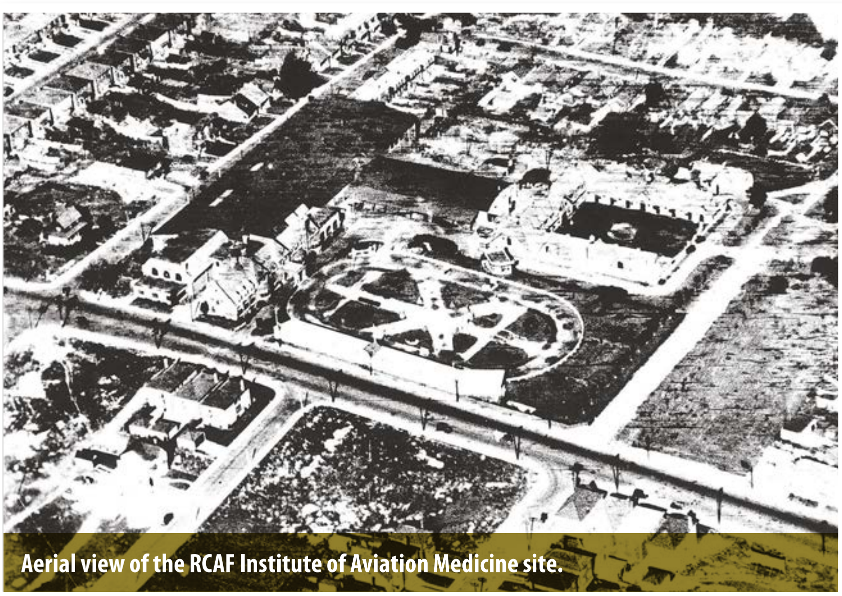
Not long after World War II, bioscience officer Roy Stubbs and his colleagues at the Royal Canadian Air Force Institute of Aviation Medicine were trying to improve the design of pilots' crash helmets and one thing they wanted to know was how much G-force it took to render someone unconscious.

"Nobody knew," said Stubbs, who commanded the IAM's Flying Personnel Medical Establishment from 1958 to 1963. "So we had accelerometers attached to our heads and bashed them against steel plates." The rationale for this seeming madness was that they wanted to design helmets to provide the maximum protection with the minimum weight. They needed to know exactly how strong to make them and knocking their heads against a wall was "the only way we could find out," Stubbs said.

He believes they got up to about 10 Gs (ten times the force exerted by earth's gravity). "We had a doctor present—not that he could do anything after you'd done it. We got pretty dizzy at times, but a couple of beers later helped."

His commanding officer wasn't quite so sanguine, however. He happened by one day, witnessed their performance and, as Stubbs recalls the encounter, inquired: "What the hell are you doing?" And then added: "I don't want you to do that anymore."

Stubbs is one of a special breed of researchers who pioneered aviation medicine in Canada and, indeed, worldwide. Driven by the demands of World War II and the advent of new aircraft that could fly higher and faster than ever before, they



Aerial view of the RCAF Institute of Aviation Medicine site.

broke new ground in studying the effects of high altitudes, low pressures and high acceleration on the human body.

These early researchers often served as their own guinea pigs, sometimes suffering serious injuries as a result. Stubbs, for example, broke his neck while testing ejection seats. “There were no human experimentation rules then—we did what we liked,” he said. “This is a time when we were trying to learn how to do things.” A former RCAF pilot himself, he said his greatest reward “was when the boys who had ejected [from their aircraft] came up to us and said thanks.”

“It was a wonderful career,” agreed Douglas Soper, a former RCAF navigator who was also a bioscience officer at IAM. “Not many people have that kind of excitement. It was, to us, a very useful thing to be doing. You felt a strong affinity for the aircrew. That’s what your job was for—to protect the aircrew. They felt you were part of the team.”

In a very real sense, these men are also part of the team that today includes astronauts and cosmonauts. The work they did on anti-gravity suits, pressure suits, helmets and oxygen masks, ejection seats, decompression sickness and motion sickness are all relevant to flying in space and their research laid a solid foundation on which today’s operational space medicine program is based.

## World War II Jump-Starts Aviation Medicine in Canada

In Canada, it all started with one man—an iconic figure whose name is instantly familiar to many Canadians, though usually not in the context of aviation medicine. Nobel Prize winner Sir Frederick Banting, the co-discoverer of insulin, was head of the University of Toronto’s Banting and Best Institute for Medical Research as war loomed in Europe. Following the Munich conference in 1938, Banting did not share the misguided hope of many that there would be “peace in our time.”

He was “more farsighted,” noted an article in the November 1946, edition of the *Journal of the Canadian Medical Services* (JCMS). “He realized the inevitability of war. Without delay, he... called upon his staff of brilliant research scientists to familiarize themselves with some problems in the field of war aviation medicine. Thus, in the event of hostilities, Canadian scientists would not be caught napping but would be prepared to come immediately to the aid of their country.”

According to Peter Allen, a former commercial airline pilot who wrote a paper on the early years of Canadian aviation medicine for the *Canadian Aviation Historical Society Journal* (CAHS), much of the credit for getting Banting involved belongs to Major A. A. James of the Royal Canadian Army Medical Corps, who had spent a year studying the state of aviation medicine in other countries. “Realizing that all countries except Germany were appallingly unprepared to support their aircrews in the coming war, James was determined to see that situation changed in Canada.” He persuaded the very busy Banting that a research program was needed because the aircraft of the time had exceeded the physical capabilities of the crews that would fly them.

Banting realized immediately that the ability to fly at high altitudes would give Allied crews a tactical advantage in war. As a result, he started a fund-raising program and brought his research

Nobel Prize winner Sir Frederick Banting.

team together with James to focus on the most urgent medical problems. The result, said Allen, is that Canada initiated "the most powerful research program in the world designed solely to protect the pilots and aircrew who were about to wage the tremendous aerial battles in the skies over Europe."

Initially Banting's team worked out of the university, but it rapidly became apparent that a more private facility was needed to do classified research. A federal government grant enabled them to purchase the Eglinton Hunt Club near downtown Toronto in 1939. Known first as the No. 1 Clinical Investigation Unit and later as the RCAF Institute of Aviation Medicine, it was a top-secret facility disguised as an aircrew evaluation unit.

One of Banting's colleagues at the U of T, Wilbur Franks, was doing cancer research before the war and it was not immediately apparent what he could contribute to aviation medicine—until he heard James explaining that that fighter pilots were blacking out during high- speed maneuvers, such as pulling up hard out of a dive or making tight, fast turns in aerial dogfights.

These moves created strong centrifugal forces that caused blood to pool in the lower part of their bodies and made it difficult for their hearts to pump blood to the brain. Deprived of oxygen (a condition called hypoxia or anoxia), pilots often experienced first a loss of vision and then unconsciousness. The military considered this one of the most pressing problems affecting the performance of their pilots; James told the IAM scientists that it would provide an enormous tactical advantage if the G tolerance of the Allied pilots could be increased.

The blackouts were a consequence of increased G-forces created by changes in speed and/or direction. One G is the force exerted by earth's gravity, which is measured as weight. Thus, objects subjected to three Gs weigh three times their normal weight. At seven Gs, blood weighs as much as iron. It's not surprising, therefore, that the heart has trouble pumping it out of the body's extremities and up to the brain. In tight turns, the fighter aircraft used during the war, such as *Spitfires* and Messerschmitt 109s, could subject their occupants to more than seven Gs. (The opposite situation occurs in negative-G conditions, or weightlessness, when body fluids tend to pool in the head rather than the legs, causing bloating and congestion. Astronauts refer to this condition as "puffy face and bird's legs." However, in the 1940s, that was an issue for the future; the JCMS article commented that "no tactical problem for protection against negative G presented itself during the war.")

What piqued Franks' interest was the fact that the pilots' problems stemmed from being subjected to centrifugal forces. He knew all about centrifuges and the damage they could do; he'd used them to spin test tubes for his cancer research and, after having too many tubes smashed by the G-forces created by spinning, he'd devised a workaround—floating the tubes in water to provide a counterbalancing pressure that cancelled out the centrifugal forces. The question immediately came to mind: could this work for humans as well?

The idea was that the water—which, like blood, gets heavier when subjected to G forces—would exert sufficient pressure against tissues in the lower part of the body to prevent blood from pooling in the veins of the calves, thighs and abdomen, thus allowing the blood to return to the heart in a more nearly normal way. The pressure also supports the arteries that carry blood from the heart. Both effects enhance the heart's ability to pump blood up to the eyes and brain even under considerably increased G loads.

Franks tried it first with mice, fashioning tiny water-filled G-suits for them out of condoms. It worked like a charm—amazingly, the mice tolerated up to 240 Gs without coming to harm. The next step was to develop a suit that could be worn by humans.

Enthusiastic about the potential of this concept to help fighter pilots, Banting sought funds to develop Franks' brain child at a time when many in government were less convinced than he that war was coming. In fact, much of their initial bankroll—the grand sum of $5000— was donated by a private citizen, Harry McLean, a wealthy, eccentric businessman known for his philanthropy.

## The Anti-Gravity Suit and the Human Centrifuge

Harry McLean's money enabled Wilbur Franks to buy the materials and hire a tailor to make the first anti-G suit, which was secretly sewn together on an old sewing machine in Franks's office. In May, 1940, he donned this first rough version of his Franks Flying Suit and climbed into a Fleet *Finch* aircraft at Camp Borden. This was the first time he had ever flown in an aircraft—and he was initiating himself with high-speed aerobatics. He and the pilot were hit with about seven Gs while pulling out of a steep dive; the pilot experienced a temporary blackout but Franks did not.

Wilbur Franks in a plane during a G-force test.

He was jubilant that his concept worked, although it had not been a pleasant experience. The suit was cut to fit him standing up but he was sitting down in the plane. "When the pressure hit, I thought it was going to cut me in two," he said later.

As a result of the tests, Franks realized that it was not necessary to cover the entire body, but only the essential areas of the lower body. He quickly modified the suit and a month later, it was worn by a Royal Air Force pilot, D'Arcy Greig, who flew a *Spitfire* in from England for the tests at Malton airport in Toronto. He became the first pilot ever to wear a true G-suit in flight.

Greig's secret report noted that in his first 30-minute test, he pulled almost seven Gs without blacking out. He added that the suit was "somewhat uncomfortable" to wear, but did not impede his handling of the plane. In another 45-minute test two days later, he reported that the *Spitfire* "was subjected to almost continuous and violent maneuvers at high speed." He estimated the maximum G forces exceeded eight Gs. (One dive produced accelerations beyond the limits of the aircraft's accelerometer.) Again, he did not experience blackouts, but reported a "considerable feeling of fatigue in the legs and feet" at the end of the flight. A third test flight of 55 minutes was done the following day, during which he once experienced very momentary symptoms of blackout.

Grieg concluded that the concept was sound but the suit itself was "not a practical proposition. However, the results obtained were of such a convincing nature that further development is strongly recommended..."

Peter Allen's CAHS paper noted that one of Greig's tests "strained the composure of Franks to its limits." Franks knew the suit reduced a pilot's 'seat of the pants' feel for the plane and it was possible to push the aircraft to the point of breaking up. During one test, Greig disappeared from the view of those watching on the ground and didn't come back for over half an hour, by which time Franks was on the verge of calling out the crash trucks. When Franks questioned Greig about where he had gone, the British pilot "stated quite matter-of-factly that a friend of his was attending a garden party on the lakeshore near Oshawa and he had put on an airshow for them with the *Spitfire*."

Franks and Banting quickly decided that continued testing of the suit in real aircraft was not the way to go. Not only were flight tests potentially dangerous and subject to the whims of unpredictable weather, they did not provide the precisely controlled environment that Franks required to understand and improve his creation. Since the development of the G-suit was still a top-secret project, they also represented a security risk; it was difficult to shield test flights from unclassified eyes.

This decision led directly to the development of a human centrifuge, the first device of its kind to be built by any of the Allied countries. The Germans had built a smaller, less sophisticated version before the war but Franks' device was the first that could mimic the effects of aircraft acceleration on the human body.

With a $25,000 grant from the National Research Council, a centrifuge was constructed in the Clinical Investigation Unit (CIU) and went into operation in mid-1941. It was a top-secret project, but there were telltale clues of its existence outside the CIU's walls. Powered by a 200 horsepower streetcar motor, it shared the city's electrical lines and every time it was fired up, streetcars on a nearby street would grind to a halt.

The centrifuge consisted of a spherical gondola suspended from a horizontal arm attached to a vertical shaft. The motor rotated the central shaft, causing the gondola to swing out on moveable joints to an almost horizontal position. The test subject sat inside the gondola in a seat resembling those in fighter aircraft. This seat was suspended independently of the gondola, allowing the subject to be positioned at different angles inside the gondola, including in an upside down position to produce negative Gs—a unique feature.

Subjects were monitored by an observer who transmitted signals into the gondola by turning on lights and sounding a buzzer. The subject responded by turning the signals off. A failure to turn off the lights indicated he had blacked out and could not see; however, he was still conscious and could respond to the buzzer. A failure to turn off the buzzer indicated the subject was unconscious.

Subjects were also monitored with electrocardiographs, electroencephalographs and by a photoelectric device attached to the earlobe that measured blood flow to the head. The latter confirmed that the volume of blood going to the head was greatly reduced when the subject experienced high G forces.

The tests led to the following conclusions:

- During the standard five second run in the centrifuge, the average man will "greyout" at 4 Gs, blackout at 5 Gs and become unconscious at 6 Gs.
- Tolerance to G forces did not increase even if subjects did repeated runs in the centrifuge every day.
- The threshold at which subjects blacked out did not significantly correlate with age, weight, or body measurements or with resting blood pressure and pulse rates.

The centrifuge was, in fact, used to evaluate humans as well as G-suits. The *JCMS* article noted that "many aircrew trainees suspected by the instructors of having a very low G tolerance were referred during the war to this Unit for testing purposes. In this way, those with abnormally low G tolerances ... were detected and transferred from pilot training before they got into difficulties."

His work with the centrifuge enabled Franks to develop the first operationally practical G-suit. It consisted of a rubber bladder covered by a non-stretchable material that forced all the pressure produced by the bladder inward against the body. "As the blood got heavier under G, so too would the water in the suit get heavier and press in against the tissues with a force sufficient to prevent the pooling of blood and to support the arteries," the JCMS article noted.

Although the bladder could be filled with air rather than water, the water-filled suit had one advantage—once it was filled, it worked automatically as soon as G forces occurred. An air-filled suit, on the other hand, required connections to the plane and a source of compressed air to pump into the bladder in flight. In the early days of the war, planes didn't have the power to spare, said Peter Allen. "The planes needed all their power to get to altitude; it's not like they had surplus power to run a generator." He said the brilliance of Franks' design was that it was completely self-contained—precisely what was needed at the time he started working on the problem.

The Franks Flying Suit Mark III was used in combat for the first time in November 1942, by the Royal Navy Fleet Air Arm, which provided air cover for Eisenhower's invasion of North Africa at Oran, Morocco. Several of the pilots who wore the suit reported that it greatly enhanced their ability to maneuver in the air and outfly enemy aircraft without experiencing blackouts.

One noted that under attack by an enemy aircraft, "I immediately went into a steep turn and pulled round very sharply, causing the enemy to spin. It recovered about 50 feet from the ground and ... attempted to land, probably very shaken." Another commented: "I had hit an enemy fighter. I watched him dive and expected him to crash. He pulled out though and started flying low down ... so I dived on him vertically and got a burst on him. After that I had to pull up sharply to avoid hitting the ground myself, but did not blackout and had complete confidence in the suit."

**An early photo of the *Spitfire*.**

Allen added that the Royal Navy pilots particularly appreciated having a week's supply of fresh water on board "in case they were forced down in the desert or at sea."

The RAF recommended adoption of the suit for operational use, saying it would provide British pilots with a significant advantage over enemy aircraft. The pilots themselves were enthusiastic about the suit and wanted to wear it during air operations, but the RAF decided to limit its use, despite having stockpiled more than 8000 units, to preserve the secrecy of the device until it could be used to greatest advantage in the invasion of Europe, codenamed OVERLORD. There was concern that if it fell into enemy hands too soon, this advantage would be lost.

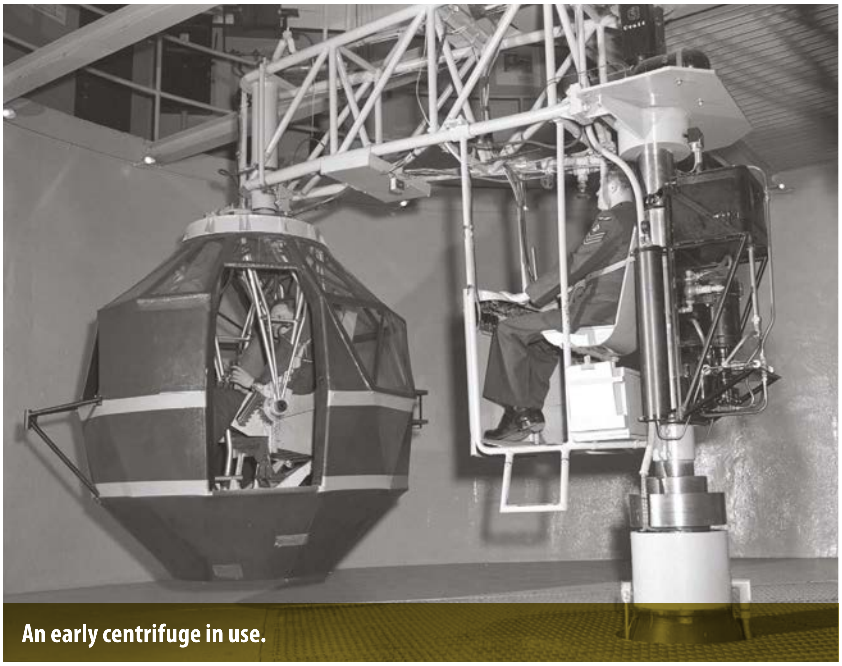
Moreover, by the time the suit was being mass-produced, the nature of the war had changed. Rather than engaging in short, furious dogfights, fighter pilots were more likely to find themselves escorting bombers over long distances—a situation that did not endear the heavy and uncomfortable water-filled suits to those who had to wear them.

"On longer range bombing missions, they were in the air for six to eight hours," said Allen. "The crews resisted the suit. There were temperature issues—how do you keep it warm? It was heavy because it was filled with water. And it was uncomfortable because it was always filled. So you had a warmth problem, a weight problem and a comfort problem."

At this time, jet aircraft were starting to make an appearance and they did have sufficient power to pump air into the pilots' G-suits. Later versions of Franks' suit did, in fact, use air- filled bladders. They were lighter and more comfortable than the water suits but they were also more complex, requiring connections to the aircraft and valves to regulate airflow. These valves were designed with a spring-mounted weight that allowed air into the suit only when the G forces exceeded 2 Gs, so pilots only flew with inflated suits when it was necessary.

Even though Franks' original suit was not used to the extent he'd hoped, his concept was the progenitor of the G-suits that were later worn not only by pilots but also by astronauts. Allen said the Canadians shared their findings with researchers who were also working on the problem in the United States, Britain and Australia. "The whole issue of acceleration had been around, but the problem just hadn't been solved. There was a lot of research into ways to deal with acceleration but none of them worked. Franks' suit was the first that worked. After Franks' discovery was provided to them, everybody got in the game but it was because of Franks' original discovery that they were even in the game."

Allen added that Franks can also be credited with pioneering the use of the human centrifuge in acceleration research. He interviewed one of the German scientists who came to the United States to work in the space program after the war. "His view was that Franks made two significant contributions—the concept of the suit and creating the first suit that worked, and also the creation of the centrifuge to do acceleration research. There was no question in his mind about the breakthroughs Franks made." This scientist told him that the German centrifuge developed



An early centrifuge in use.

before the war was "not a true human centrifuge" that could be used for research on the effects of acceleration.

Charles Bryan was a doctor who worked with Franks on the centrifuge studies in the 1950s and 1960s. His research focused on the effects of acceleration on the lung. He found that the alveoli—the tiny sacs at the bottom of the lung where oxygen actually transfers from the lung to the blood, became greatly compressed. This caused the subject to experience a lack of oxygen because "the bottom of the lung was essentially collapsed and almost airless."

Bryan said the legacy of the G-suit is as important today as it was 60 years ago. "With the latest generation of fighters, G forces have come back as a really serious problem. G-forces with modern fighters are potentially very high indeed. They're dodging rockets, doing terrain flying up and down, turning all the time, so G forces have come back with a vengeance and are as important as they were during the last war."

Mark III and Mark VI g-suit.

As for Frederick Banting, he didn't live to see the success of the invention he had championed. He was killed in February 1941, when the plane he was flying in crashed in a snowstorm near a frozen lake in Newfoundland. Two of the four people on board were killed and Banting and the pilot, Joseph Mackey, suffered serious injuries. Mackey was able to leave the plane to search for help, but the severely injured Banting died before the pilot returned.

Banting had been on his way to England to enlist the support of the British military for continued development of the Franks Flying Suit. He was reportedly carrying a copy of the suit on the plane with him. "It may be mythology, but that was the word of mouth that got carried down," said Bryan. "The timing was absolutely right. Franks had just produced the suit so it was logical to take it to the Brits at that time."

The purpose of Banting's trip was not for public consumption, however. The newspaper article mentioned that Banting was on a "secret" medical mission and quoted an official of the National Research Council saying that "when the time comes and his contribution can be adequately assessed, it will be clear that no one has done more for our cause."

In his paper, Allen noted that "thousands of Allied fliers would likely never realize how great a part he played in increasing their chances of survival in the skies over Europe and Asia. It is incredibly ironic that his last great field of research would involve the instrument of his untimely death."

Allen said the early Canadian effort in aviation medicine was unequalled, comparing it to the U.S. Apollo program: "Never before had so many scientists been readily diverted to a single research project of such magnitude. Never before had so much been accomplished in so little time. Many years later, as Project Apollo unfolded from the U.S. Manned Space Program, the scale of Sir Frederick Banting's research efforts in aerospace medicine would finally be matched by another country."

Editor's note: One of the last remaining original Franks Flying Suits can be found on display in the Dr. Wilbur R. Franks building, fittingly named after the suit's creator, at the Canadian Armed Forces School of Survival and Aeromedical Training at Canadian Armed Forces Base Winnipeg, Manitoba.

***In the next issue: The development of pressure suits and oxygen masks.***

DOSSIER

Photo: LS Alex Bouchard

# Flight Safety and the Canadian Army

**by Colonel Jim Kile, Canadian Army Surgeon, Ottawa**

Recalling my first posting to Petawawa in 1998 as the Base Surgeon, I remember wondering why the hockey rink on one of Canada's largest army bases was called the Silver Dart after an airplane and that one of the main entry gates was named after the pilot. It was later that I learned the first powered military aircraft flight took place on 31 July 1909 at Camp Petawawa. It was an inauspicious occasion as the aircraft or rather the notion of air power did not impress the army. The plane flew poorly and on its 5th flight, crashed upon landing. The Silver Dart never flew again. Therefore, it seems to me that the notion of powered flight safety likely began that day on an army base over a century ago.

Over 100 years later, much has changed. After taking flight in the early part of the last century, the Royal Canadian Air Force (RCAF) has become a formidable force with a well-entrenched culture of safety. Concomitantly, the global landscape has evolved as well. Advancements in and the ubiquitous availability of technologies harmful to our security; the advent of global warming; the rebalancing of power within the international state system; the rise of ethnic flashpoints; terrorism and dangerous rogue state and non-state actors have forced the Canadian Armed Forces to rethink mission strategies. To this end, the Canadian Army's (CA) current mission is to generate combat-effective, multipurpose troops who can deliver focused and integrated land effects within and among other elements including the joint environment. As the CA moves toward the construct of Adaptive Dispersed Operations within a joint environment, it is self-evident that it cannot meet its mission without full and successful integration with air and sea elements.

Afghanistan has shown that in particular air power and capability are essential to mission success at the strategic, operational and tactical levels. Getting soldiers where they need to be starting strategically with embarkation in Canada and terminating tactically with rapid movement of soldiers around a fluid battlefield are vital to success. Further, since the advent of the first dedicated military airframes during the Korean War for medical evacuation, survivability from battlefield injuries has dramatically improved. It is plain that air medical transport has become a key contributor to Canadian and allied combatant survivability in today's battle space and that it will continue to be in future conflicts.

All this to say, that as the integration of air capability in support of land offenses increases, the idea of Flight Safety takes on a greater meaning for the CA, as designated aircraft and committed air crew move soldiers to, from and around the battlefields of the 21st century. The fundamental principles of the CAF's Flight Safety program and the rigour in which they are applied has no doubt lent to a strong sense of confidence from the Army leadership that soldiers will be delivered to the fight always and in a timely fashion. Moreover, as the CA Surgeon, I take comfort in the fact the RCAF has the capabilities as well as dedicated and well-trained crews to ensure the upmost safety of Health Services personnel and their patients as they are transported out of harm's way.

DOSSIER

Photo: MS Ronnie Kinnie

# Royal Canadian Navy Surgeon: My View on Flight Safety

**by LCol Scott Malcolm, Royal Canadian Navy Surgeon, Ottawa**

As a Medical Officer who wears the uniform of the Canadian Army, is trained as a Flight Surgeon and who is the Medical Advisor to the Commander of the Royal Canadian Navy (RCN), I feel well positioned to provide my views on Flight Safety, including how it bridges the environments and the role Health Services personnel can play in making it an integral part of Canadian Armed Forces culture.

For decades now RCN Operations have been supported by the Royal Canadian Air Force (RCAF), often as air detachments embarked on board their vessels. While always amicable in their working relationships, culturally the RCN and RCAF remain very different. However, newer technologies in the form of unmanned aerial vehicles have already started to make their way on board, providing RCN personnel with their very own aerial capabilities. Will this perhaps be the incentive for a cultural shift?

I would suggest that this potential clash of cultures leaves those Health Services personnel on board the various RCN platforms uniquely poised to help shape a new common culture between the two elements, that culture being one of Flight Safety.

Trained as Operational Flight Surgeons or in Basic Aviation Medicine, the Medical Officers and Physician Assistants that provide integral medical support to the RCN have already been indoctrinated into the Flight Safety culture. Yet their time at sea has wizened them to the RCN culture steeped in ritual and tradition. As a trusted advisor to the Command team, this cultural "cross-pollination" of Health Services personnel may represent the medium through which a culture of Flight Safety within the RCN is hoisted on board and takes flight.

Ready Aye Ready

Photo: Sgt Matthew McGregor

DOSSIER

# Fatigue

by Lieutenant-Colonel Helen Wright, 1 and 2 Canadian Air Division Surgeon, Winnipeg

There is a new weapon being used in professional sports: sleep. Research has shown, time and time again, that fatigued people make more mistakes, show decreased vigilance, have difficulty sustaining attention, and have memory difficulties compared to people who are well-rested.[1] Sports teams such as the Seattle Seahawks, Toronto Raptors and Vancouver Canucks have recognised this impairment, and are taking steps to prevent it.[2] They want every competitive edge they can get. As a result, a cultural shift is taking place in North American professional sports. Active fatigue management using wrist activity/sleep monitors, timed light exposure, carefully planned sleep schedules, and other tools are being used to optimise rest and performance. Professional sports teams are looking for optimum performance, but often have to deal with challenging work schedules, working regularly at night, traveling to different cities across multiple time zones, staying in hotel rooms ... sound like anyone you know? This also applies to many Royal Canadian Air Force occupations and functions. But one does not need to travel or be a shift worker to be fatigued. It is well known that many North Americans are simply not getting sufficient sleep in their day-to-day lives.

Studies indicate that the average amount of sleep needed in order to sustain optimum alertness is eight hours of sleep per day. There is individual variation and so some people can function well on less sleep than this, but they are few in number.[3] Consider how much sleep you get when on leave or any time when there are fewer constraints on how long you sleep. This will give you an idea of how much sleep you need to be at optimum performance. Track when you naturally go to sleep and wake by keeping a record when on leave, and then use that amount of sleep time as your target during work weeks.

Sleep restriction (e.g., getting five or six hours of sleep a night rather than eight) will decrease mental function. In addition, it takes several nights of full sleep to recover from the sleep debt of a string of nights of poor sleep. The effect of sleep restriction depends on the amount of sleep you are missing and appears to be cumulative.[4] Chronic restriction of sleep to six hours or less per night produced cognitive performance deficits equivalent to as much as two nights of no sleep at all.

Photo: Canadian Forces Combat Camera

Fatigue is not just about getting enough sleep. Fatigue is a physiological issue associated with a complex interaction of insufficient sleep, long duty periods, shift work, and circadian shifts. The impact of fatigue can be insidious since the impairment may not be clear to the individual and there is no method to measure fatigue directly. There is an extensive number of studies demonstrating the influence of sleep deprivation on mental performance.[5] Lack of sleep impairs performance particularly on routine, repetitive tasks requiring vigilance. Even relatively moderate sleep restriction can seriously impair waking performance, but self-sleepiness ratings suggest that people are unaware of these increasing deficits.[4]

There are also performance consequences of fatigue for sustained wakefulness (see Figure 1). The performance of a person who wakes at 0700 hrs and stays awake for 17 hours until midnight will be as impaired as that of someone with a blood-alcohol concentration (BAC) of 0.05%, the legal driving limit in many places. A person who wakes at 0700 hrs and then stays awake for 23 hours until 0600 hrs the following day will have a performance as impaired as someone with a BAC of 0.10%. There are differences between being fatigued and being drunk; response speeds and accuracy on some performance measures indicated fatigue can be worse than alcohol.

***"The performance of a person who wakes at 0700 hrs and stays awake for 17 hours until midnight will be as impaired as that of someone with a blood-alcohol concentration (BAC) of 0.05%, the legal driving limit in many places."***

# DOSSIER

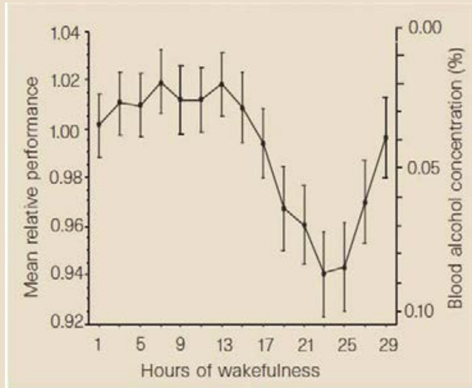



**Figure 1. Cognitive performance over hours without sleep relative to blood alcohol concentration.[6] This research clearly indicates that one night of sleep deprivation can leave you more impaired than would be acceptable for driving a vehicle. Performance is influenced both by lack of sleep and the circadian rhythm. There is a circadian influenced improvement after the 25th hour of no sleep corresponding to the morning after a missed night of sleep. It is important to note that without sleep this recovery does not return to the person's usual performance level.**

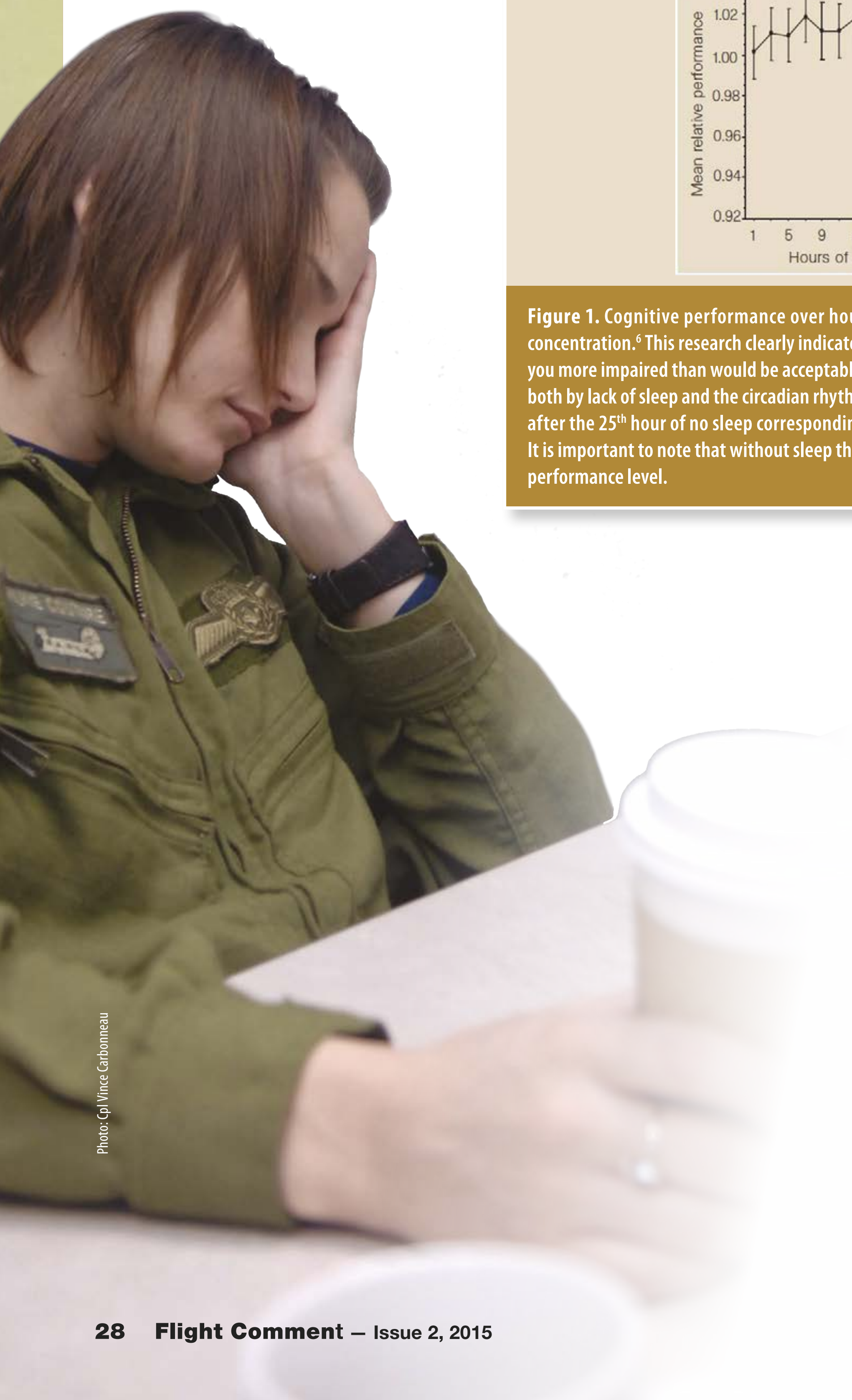


Photo: Cpl Vince Carbonneau

## Reduce Fatigue

Get enough sleep. Education, scientific scheduling, napping strategies and, in certain cases, medications, and other tools can assist in managing fatigue; but, getting enough sleep is core.

## Circadian/Shift Management

RCAF members who travel across time zones or are shift workers are subject to circadian stress. Supervisors can consult their local flight surgeon for ways to help crews to shift to the new time zone/shift efficiently and optimize performance.

## Individual Responsibility

Most believe that fatigue management is a matter of cooperation between the individual and the system. While scheduling and operational tempos are important for managing fatigue, you, the individual, have a key role to play. You are responsible for planning and using your rest periods effectively in order to minimize fatigue.

## Strategies for Optimizing Sleep Opportunities:[1]

- When possible, wake up and go to bed at the same time every day to avoid circadian disruptions.
- Use the sleeping quarters only for sleep and not for work.
- Establish a consistent and relaxing bedtime routine (e.g., reading, taking a hot shower, and then going to bed).
- Perform aerobic exercise every day, but not within two hrs of going to bed.
- Make sure the sleeping quarters are quiet, totally dark, and comfortable. For this to work, day workers should be housed separately from night workers.
- Keep the sleep environment cool.
- Move the alarm clock out of sight so you can't be a clock watcher.
- Avoid caffeine in drinks and other forms during the afternoons/evenings.
- Don't use alcohol as a sleep aid (it may make you sleepy, but you won't sleep well).
- Avoid cigarettes or other sources of nicotine right before bedtime.
- Don't lie in bed awake. If you don't fall asleep within 30 min leave the bedroom and do something relaxing and quiet until you are sleepy.

## Effects of Fatigue:[5]

- Lapses in attention
- Loss of vigilance
- Impaired judgement
- Impaired reasoning and decision-making
- Impaired problem solving
- Delayed reactions
- Loss of short term memory
- Reduced situational awareness
- Diminished crew coordination
- Tendency to abbreviate or skip routine checks, accepting "short cuts"
- Increasing frequency of errors of omission
- Low motivation to perform "optional" activities
- Irritability and impatience
- Poor assessment of risk
- Failure to appreciate consequences of action
- Measurable changes in performance
- Micro sleep (falling asleep inadvertently in 10 seconds or less).

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DOSSIER

# Mental Health and Flight Safety

by Major Aaron Minkley, Flight Surgeon, Aeromedical Standards and Clinical Services, 1 Canadian Air Division Surgeon Staff

The World Health Organization defines being mentally healthy when "an individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively and is able to make a contribution to his or her community."[1] Any disruption to your well-being may affect your mental health and can impair your ability to safely carry out your job. Even in the absence of overt mental illness, stress and anxiety have an impact on motivation, concentration and commitment with predictable consequences on flight safety whether you are flying, maintaining aircraft, or supporting Royal Canadian Air Force (RCAF) operations.

## Mental Illness in CAF

One in five Canadians will develop a mental illness in their lifetime.[2] The most common psychiatric diagnosis in Canada and the RCAF is major depression, while the most common mental illness related to operations is post-traumatic stress disorder.[3] The 2002 Canadian Armed Forces Mental Health (MH) Survey showed that 15 percent of all CAF personnel experienced MH symptoms in the previous 12 months.

Over the last year, 192 of the 835 (23%) aircrew files reviewed by Aeromedical Standards included a MH diagnosis. Of those 192 files, 92 (48%) required a temporary grounding period in order to ensure flight safety, but only four (2%) were permanently grounded.

It is essential that you discuss mental health concerns with your Flight Surgeon as soon as possible. Do not allow early symptoms of stress to develop into a clinical psychiatric syndrome. Mental health exists on a continuum between healthy and ill (figure 1). Early assessment and treatment, which may include counselling, psychotherapy or medication, can help reduce time away from work and promote recovery. Remember, the flight safety risk of decreased concentration exists before you are able to identify any MH symptoms in yourself. Although some CAF members employed in safety sensitive positions need some medical employment limitations during initial treatment, once recovered, the majority of CAF members with mental illness are able to return to full duties, including piloting aircraft.

> *"Any disruption to your well-being may affect your mental health and can impair your ability to safely carry out your job."*

## Health Services Response

The Canadian Armed Forces Health Services are committed to providing evidence based best practice health care. Following the release of the Surgeon General's Mental Health Strategy in 2013, we undertook a nationwide goal to fill all vacant mental health positions, developed Video Teleconference solutions for many underserviced areas while ensuring access to MH in both French and English, and established MH wait time targets. The RCAF Surgeon and the Senior Staff Officer Search and Rescue (SAR) convened a Road to Mental Readiness Writing Board to develop a SAR specific resiliency training program with the intent to provide occupationally focused resiliency training throughout the RCAF.

> *"One in five Canadians will develop a mental illness in their lifetime."*

## Preserving Flight Safety

All members of the RCAF have a role to play in Flight Safety. It starts with recognizing your own limitations and being fit to work when you arrive. Mental illness, like any other health concern, can affect your ability to safely perform your job, whether by reduced concentration, inattention, anxiety, or medications. If you think you need help, talk to your Flight Surgeon or other healthcare staff. If you think others are struggling, encourage them to seek help. If someone is worried enough to mention it to you—listen and take action.

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***"Remember, the flight safety risk of decreased concentration exists before you are able to identify any MH symptoms in yourself"***

| | Healthy | Reacting | Injured | Ill |
|---|---|---|---|---|
| **Mood** | Normal mood fluctuations; Calm & takes things in stride | Irritable / Impatient; Nervous; Sadness / Overwhelmed | Anger; Anxiety; Pervasively sad / Hopeless | Angry outbursts / agression; Excessive anxiety / panic attacks; Depressed / suicidal thoughts |
| **Attitude and Performance** | Good sense of humour; Performing well; In control mentally | Displayed sarcasm; Procrastination; Forgetfulness | Negative attitude; Poor performance / Workaholic; Poor concentration / decisions | Overt insubordination; Can't perform duties, control behaviour or concentrate |
| **Sleep** | Normal sleep patterns; Few sleep difficulties | Trouble sleeping; Intrusive thoughts; Nightmares | Restless disturbed sleep; Recurrent images / nightmares | Can't fall asleep or stay asleep; Sleeping too much or too little |
| **Physical Symptoms** | Physically well; Good energy level | Muscle tension / Headaches; Low energy | Increased aches and pains; Increased fatique | Physical illnesses; Constant fatique |
| **Social Behaviour** | Physically and socially active | Decreased activity / socializing | Avoidance; Withdrawal | Not going out or answering phone |
| **Alcohol and Gambling** | No/limited alcohol use / gambling | Regular but controlled alcohol use / gambling to cope | Increased alcohol use/gambling - hard to control with negative consequences | Frequent alcohol or gambling use - inability to control with severe consequences |

**Figure 1.** Mental Health Continuum. This model provides a guideline to identify signs that may indicate further assessment from a qualified medical/mental health professional is required.[3]

DOSSIER

Photo: MCpl Patrick Blanchard

# Aircrew and Melanoma Risk

**by Major Rachel Morrell, Canadian Armed Forces Environmental Medicine Establishment, Toronto**

Skin cancer is the most common cancer diagnosis in Canada, with over 80,000 new cases annually. While basal cell and squamous carcinoma occur most often, melanoma is the most serious type of skin cancer, causing over a thousand deaths per year nationwide. The *Journal of American Medical Association* (JAMA) Dermatology recently published two articles discussing a potential increased risk of melanoma seen in flight crew, leading to news reports trumpeting that airline crews have twice the risk of melanoma related to the general population.

So what does that mean for our Royal Canadian Air Force flight crew? Are our personnel at greater risk of melanoma? To answer this question, we first need to take a look at what the general risk factors for melanoma are, consider the flight environment, and then examine the current reports with a critical eye.

Melanoma forms from the melanocytes at the base of the epidermal layer of the skin, and the major environmental risk factor for developing melanoma is sun exposure and the subsequent effects of ultraviolet (UV) radiation. Melanocytes produce melanin, a skin pigment, in response to UV radiation damaging the skin—this tanning response helps to protect the skin against additional damage from UV light. Frequent intense sun exposure can cause damage to melanocytes that over time leads to melanoma. Fair skinned people, those with multiple moles or nevi, and people with a family history of melanoma are at increased risk.

The UV spectrum ranges from 380 to 100 nm, and is subdivided into UV-A, UV-B, and UV-C spectra. UV solar radiation is partially absorbed by the ozone layer, and the level of UV radiation will vary depending upon the sun, clouds, atmospheric particles, location, and altitude. Shorter wavelengths are absorbed more efficiently by the ozone layer, such that only half of UV-B and no UV-C radiation will reach the earth's surface.

UV-B radiation penetrates into the first layer of the skin, the epidermis, and is the most damaging to skin cells—it is the major cause of sunburn and has the strongest association with the development of all types of skin cancer, including melanoma. UV-A radiation travels through the epidermis into the dermal layer of the skin, and was once thought to contribute to aging signs in the skin but not to the development of skin cancer, which forms in the epidermis. UV-A is the main component used in indoor tanning beds, and the increased prevalence of skin cancer among tanning bed users has led to the recognition of UV-A as a human carcinogen in addition to UV-B.

In the aviation environment, UV exposure is of potential concern because flight crew may encounter UV levels significantly higher than those at ground level. For every 3000 foot increase in altitude above sea level, there is a corresponding fifteen percent increase in UV radiation. The UV radiation level may also be increased due to reflection when flying over clouds or snow: fresh snow can reflect up to 94% of UV radiation, leading to a significant increase in amount of UV exposure. While

cockpit windscreens will block the majority of UV-B radiation, UV-A radiation transmittance will vary with the type of material: a Federal Aviation Administration report testing optical radiation transmittance of aircraft windscreens performed under laboratory conditions found that six different multilayer composite glass windscreens transmitted 54% of UV-A radiation; the two plastic windscreens transmitted 0.41%.

The research reported in *JAMA Dermatology* by a research group from the Mount Zion Cancer Research Center in San Francisco was of two types: the first article was a meta-analysis looking at melanoma and pilots and cabin crew, and the second was a research letter in follow-up taking in flight measurements of UV-A levels in a cockpit. A meta-analysis is a systematic statistical review where the researcher combines the results of data from several previous studies to see if a significant effect can be seen from the aggregate data that was not apparent or unclear in the individual smaller studies. This particular meta-analysis combined the findings of 19 previous studies for a total of 266, 431 participants from eleven countries. Most of the studies were focused on pilots, and four included cabin crew. The study examined the data for the ratio of the incidence of melanoma among aircrew compared to the general population as well as for the ratio of melanoma mortality rate among aircrew compared to the general population. They found that aircrew were twice as likely to have melanoma, and had a 42% higher mortality rate from melanoma. In their follow-up report, they took in-flight measurements of UV radiation in a general aviation turboprop plane with a plastic windshield, and found that the UV-A levels in the cockpit for a one hour flight at 30,000 feet could result in the equivalent of a 20 minute session in a tanning bed.

So what does all of that mean? To put things in perspective, the number needed to harm found in the meta-analysis for a melanoma diagnosis was 4695. Put another way, with all other factors being equal, if 4695 people were exposed to the 'risk factor' of flight, one person would develop melanoma that would not have otherwise. It is also possible that the observed increase in melanoma might be related to other factors not accounted for by the original studies the data was taken from – perhaps aircrew are more likely as a group to spend time in sunlight or tanning, or more aircrew were fair-skinned than in the general population. Additional investigation to examine the exposure of aircrew to UV radiation is needed to make a more definitive statement, although these reports do suggest there might be an increase related to the aviation environment.

> ***"[...] UV-A levels in the cockpit for a one hour flight at 30,000 feet could result in the equivalent of a 20 minute session in a tanning bed."***

What we do know for certain is that the melanoma incidence overall in Canada has been increasing over the past two decades, and that decreasing your exposure to UV radiation can help to prevent all types of skin cancer. Everyone should wear sunscreen that provides both UV-A and UV-B protection, with a minimum SPF 30 to decrease their risk. Keep in mind that it is not only being outdoors on a sunny day that can expose you to UV radiation— you can still be exposed to UV on a cloudy day ... or sitting in the cockpit at 30,000 feet.

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# G-LOC

by Captain Gabrielle Chafe, Applied Sciences Group, Canadian Armed Forces Environmental Medicine Establishment, Toronto

Thank you to all who answered the G-Induced Loss of Consciousness (G-LOC) survey. This survey was important to determine the occurrence rate of G-LOC. A pilot in control of an aircraft can become disabled by a G-LOC event. With any G-LOC episode, there is the potential for loss of life and aircraft. Reducing the occurrence of G-LOC is paramount to reducing the risk of loss and to increasing flight safety. Surveys are one tool to monitor occurrence rates and determine possible factors that can be targeted to reduce G-LOC occurrences. Our survey report includes recommendations to further reduce G-LOC occurrences.

Now, check out what you said! For those who did not participate, check out what your colleagues said!

## Good news!

The G-LOC occurrence rate has gone down. In 1986, the G-LOC rate per 10 000 hrs of flight was 7.5 in the CT114 *Tutor* training aircraft. Ten years later, the 1996 survey showed a decreased rate of 2.8, with the same aircraft, and in 2013, the rate was 1.8 in the CT156 *Harvard II*, one of the current training aircraft.

You may ask, "Who is experiencing G-LOC?"

As determined by the accumulated hours on the aircraft at the moment, of the reported G-LOC incidents, 52% (12/23) of the participants who suffered a G-LOC had less than seventy-seven hours on the aircraft in question. Seventy-seven hours is approximately equivalent to the current minimum required hours to accomplish Phase Two of pilot training. Additionally, 68% (15/22) of those individuals had not yet had their centrifuge training. In short, participants with less flying experience (fewer hours on aircraft) and less exposure to the High Sustained G (HSG) environment are more likely to suffer a G-LOC episode. The human body is very adaptable; it reacts to overcome many challenges, and HSG is no exception. The body will adjust, but it does need to be conditioned. It has been shown that the body needs to experience at least three HSG experiences (from plus 4.5 G to plus 9 G for 15-30 seconds) within a 5-7 day period to be at peak performance to withstand G forces.

Photo: Sgt Robert Bottrill

Additionally, G-awareness checks are carried out prior to an expected manoeuvre exceeding a certain amount of G (dependant on type of fleet). These checks are required to induce initial physiological responses in immediate preparation for an HSG load, as well as give the pilot a sense of how their body is dealing with G on that particular day. Training for HSG, being exposed to the HSG environment and assessing G-tolerance on the day of flight all work together to decrease the rate of GLOC.

## An unexpected result

There are more G-LOC episodes occurring in the spring and summer months than the fall and winter. Admittedly, there are more flights in the spring and summer due to better weather and longer days. However, with the G-LOC rate normalised with the number of flights, the spring and summer G-LOC rates are still higher. One hypothesis is that there is increased stress due to warmer weather. Environment Canada reports that Moose Jaw temperatures can reach maximums of 39-42°C! Reports of ambient temperatures of 25-32°C can result in temperatures reaching up to 31-41°C within a cockpit. A warmer ambient temperature, combined with the donning of many layers of protective equipment (dual layer flight suit, gloves, Life Preserver/Survival Vest, helmet, G-suit), the greenhouse effect of the glass canopy, and other contributors (fatigue, dehydration, hunger, stress, anxiety) can all add up to having a really bad day!

## Our recommendations

Especially for less experienced pilots, we recommend exposure to the HSG environment (4-4.5 G for 15 seconds) at least three times on three separate days within a 5-7 day period before attempting any aerobatic manoeuvres. This will physically increase the body's capacity to withstand HSG. In addition, G- awareness checks are required immediately prior to HSG exposure. If the weather forecast says it is going to be a warm day (anywhere near 25°C), plan the aerobatic mission for the morning while reserving missions involving lesser G perhaps for the afternoon. If you are not feeling at the top of your game, for any reason whatsoever, plan to fly a lower G mission. That is the best way to make sure you don't have the worst day of your life.

***"It has been shown that the body needs to experience at least three HSG experiences (from plus 4.5 G to plus 9 G for 15-30 seconds) within a 5-7 day period to be at peak performance to withstand G forces."***

Photo: DND

# Presbyopia and the Aging Aircrew

by Capt Alex Duong, Flight Surgeon, Canadian Armed Forces Health Services Centre, Ottawa

One of the most common eye disorders we encounter amongst our aging aircrew is presbyopia: the inability to focus on objects up close. In the normal eye, images are formed by light refracting through the cornea and lens and onto the retina. The eye can focus on objects at varying distances by changing the shape of the lens with a series of muscles. As we age, the elasticity of the lens is lost, with vision difficulties becoming progressively more noticeable by 40 to 50 years of age. This defect, however, is simply compensated for by using reading glasses or bi/trifocals.

Although this is a natural part of the aging process, it can create difficulties in accomplishing aircrew duties. The obvious problem is reading close-up text, maps and charts. Many studies have analyzed the effect of near vision on pilot performance. A study done in 1995 investigating the effect of reduced near vision on simulated Instrument Flight Rule approaches showed a worsening in performance due to difficulties viewing approach plates and radio buttons.[1] In a 2005 study by Defense Research and Development Canada, pilot subject matter experts (SME) noted one common critical near-vision task was reading and understanding approach plates at night.[2] These tasks were

made more difficult by poor interior and environmental lighting, cockpit vibrations and the use of night vision goggles or laser eye protection. In addition, the SMEs noted that vision transition, whereby pilots switch from scans inside the cockpit to outside the aircraft, can be a challenge due to the time it takes the eye to focus.

In order to test near vision, we ask patients to read a series of continuous paragraphs printed in a Times New Roman font which successively vary in size. The size of each paragraph corresponds to specific "N" values which are linearly related (i.e. N5 is half as large as N10 text). Although most aircrew have a minimum occupational standard of "V3," which corresponds to a correctable vision (ie. with glasses) of N5 in the better eye and N6 in the other eye (at 30 cm)[3], pilots and SAR techs have a "V2" requirement, which means a minimum uncorrected near vision (i.e. without glasses) of N10 in both eyes or N8 in the better eye and N12 in the worse at 30 cm as well as the above correctable requirement.[4]

Corrective prescription lenses (either contact lenses or glasses) themselves, are usually regarded as safe.[5] Regardless of whether a pilot chooses to wear contacts or glasses, their fitness to fly will be determined in the same fashion by 1 Canadian Air Division (1 CAD) Headquarters.

For experienced aircrew personnel whose vision is below the standard, an administrate review from the Director of Medical Policy and 1 CAD is conducted. However, there are usually never any significant permanent restrictions assigned other than "must wear prescription lenses while flying."[6]

The frequency of eye exams regardless of whether one is in a flying or non-flying position is every four years until age 40 (or two years if the member wears glasses), every two years after age 40 and annually after age 46.[7] With age, presbyopia is an inescapable reality. However, because of the critical role it plays in the duties of pilots and other aircrew, it is important to be aware of the importance of the near vision standard in the aircrew eye exam.

***"The frequency of eye exams regardless of whether one is in a flying or non-flying position is every four years until age 40 (or two years if the member wears glasses), every two years after age 40 and annually after age 46."***

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# *Never Pass* on *Gas*

**by Major Chris Spearin, Deputy Commanding Officer, 12 Air Maintenance Squadron, Shearwater**

It was mid-July in the Mediterranean and the United Kingdom (UK) Task Group had just been turned around in Gibraltar to proceed to the eastern Mediterranean Sea to prepare for a Non-Combatant Evacuation Operation in Lebanon. We were flying a *Merlin* Mark 1 off of Her Majesty's Ship (HMS) *Illustrious* and were tasked to conduct a Very Important Person transfer of the staffs of the Commanders UK Maritime and Amphibious Forces (COMUKMARFOR and COMUKAMPHIBFOR) to Royal Air Force station Akrotiri for a planning meeting. The ships were heading east at best speed and we were tasked to launch as soon as possible to get them ashore. The weather at Akrotiri was visual meteorological conditions and winds were light out of the west.

For helicopters, like any aircraft, there is always a trade-off between the load and fuel. Unfortunately it was the middle of the summer and the winds were light so this didn't help our situation. There were a total of four crew and 14 passengers (pax) on the aircraft. HMS *Illustrious* with COMUKMARFOR embarked was approximately 280 nautical miles (NM) west of Akrotiri and HMS *Bulwark* with COMUKAMPHIBFOR embarked was about 120 NM ahead of *Illustrious*. We had eight pax leaving *Illustrious* with us and another six to pick-up on *Bulwark* before proceeding to Akrotiri. We left *Illustrious* with our pax and as much fuel as we could take for the transit to the *Bulwark*. The transit was uneventful and we landed on to pick up the rest of our pax and get a drink of gas. After landing on, it started to become apparent that our desire to take fuel hadn't been passed to the *Bulwark* so they weren't ready to fuel us. It was going to take at

> ***"[...] it would have only taken a few more knots of headwind to have put us in a ditching situation and a lot of people's lives at risk."***

least another 30-40 minutes to recirculate the fuel and complete the rest of the preps. At this point we had already been on deck for about 30 minutes and had 14 senior officers on the aircraft. On top of that, our ETA in Akrotiri already had us late for the start of the planning meeting. So there was a bit of pressure (probably both actual and perceived) to get off the deck. We spun the numbers and figured we had enough fuel to safely get there. Besides, even if we had waited for the fuel, we would have only been able to take another 400-500 kilograms due to the weight of the pax.

On our way ashore the tail wind wasn't giving us the push we had expected. Eventually, the winds managed to swing around to the east and actually turn into a headwind. This reduced any extra fuel we had to just enough fuel to get there. This obviously raised the stress level of the crew and we started paying a lot of additional attention to fuel situation. In the end, we managed to get feet dry just as our low fuel warning came on. Fortunately, this was also coincident with us being on final for landing. We elected to do a running landing and minimize any changes to the aircraft attitude to reduce the risk of flaming out an engine. We landed and dropped off our pax without incident.

In hindsight, had we waited on the deck at HMS *Bulwark*, we would have launched about 10 NM closer to Akrotiri with about 30 minutes more fuel. Although everything ended up alright, it would have only taken a few more knots of headwind to have put us in a ditching situation and a lot of people's lives at risk. This occurred eight years ago and I've never put myself in the same situation since then.


Photo: Mr. Jonathan Evans

# A Quick Stop

by Captain Greg Boyd, Air Force Standards, 1 Canadian Air Division Headquarters, Winnipeg

We were in Kandahar, six weeks into our eight-week rotation. My CC130 *Hercules*' crew of six all had several deployments in their logbooks and were very comfortable with the planned mission of six legs criss-crossing Afghanistan to move people and cargo. It was the usual 40 degrees Celsius and dusty. Our primary focus on start-up was to be quick and get the air conditioning on as soon as possible once bleed air was online. The sweaty helmets we flew with were not conducive to extended ground operations. Of course, after my personal comfort, it was necessary to be quick to not over heat the engine oil and have to abort the mission.

We would fly from either seat to enable easier upgrades for the First Officers (FO) once back home. I was in the right seat and busy with the usual last minute flight planning and endless base operations (Ops) calls. The engine start is primarily done by the left seat and the Flight Engineer on the legacy *Hercules*. My job was to stay quiet and monitor for any problems. I stayed quiet, but in my head I was chanting to hurry up; my ear cups are slowly filling with sweat. I remember it was fun to let it build up to submerge the earlobe and then let it flow down your neck for a brief respite. Sometime during the engine start, we got a call from Ops that our parking spot was needed immediately. In fact, another *Hercules* was engines-running, waiting behind us at that time. The lack of parking was a constant stressor during our operations in that war torn country.

Finally the engines were started and the first somewhat cool air is starting to blow on my clammy forehead. Somehow, we decided as a crew to move forward 100 metres prior to our usual sequence of checks to accommodate the other *Hercules*. We are adaptable, and that is the key to airpower, right? We had just started our checks that would normally all be done while parked. One key step was me turning off the utility hydraulic pumps to check the system. Then Operations called ... again. In my frustration and personal discomfort I advised the left seat to just go ahead and make room for the guy behind us; we can finish this check then.

***"I have no Brakes!"*** This is the colourful-adjective sanitized version of what my FO shouted.

Sometimes, we can move faster than we can think. I saw the parked US Marine F-18 *Hornet* about 100 metres on our nose and immediately knew what the problem was. I instinctively reached forward and flicked the two engine driven hydraulic pumps to ON. I actually remember thinking as I hit the second switch "NOOOOOOOOOO!" Too Late.

I can tell you, the sound of a loaded *Hercules* receiving an instantaneous 3000 pounds per square inch of pressure to the brakes is forever in my memory. We were only rolling at five knots and had plenty of time to stop before the F-18. We used about two centimetres of that distance. I mean it was snap-the-shoulder-straps violent. Unfortunately, one of my Loadmasters was still walking around and completing his checks. Second hand reports describe a wide eyed combat Loadmaster doing a five metre 'Superman' above the troops. Luckily, the packed *Hercules* has very little exposed floor and he gracefully landed on the interlocked knees of some very surprised (and probably now quite scared) soldiers. His heavy helmet and flak vest also meant he was reasonably well suited to get in an early solo flight.

Like any incident, many things conspired to arrive at the end result:

- We were getting too casual with day to day operations in a war zone.
- We were perceiving pressure that really wasn't that critical.
- We were physiologically uncomfortable.
- We were getting so confident, that we weren't double and triple checking when we did something different, dumb or dangerous.

In the end, we could have let the guys behind us wait. Or, if we did need to move, a simple brief to the crew would have trapped the error of taxiing at the exact moment the right seat pilot turns off the brakes.

Photo: DND

# Are you ready for the worst?

**by Sergeant Daniel Allaire, 430 Tactical Helicopter Squadron, Valcartier**

Have you ever carried out a routine maintenance task when suddenly things go terribly wrong? With time and task repetition we often forget that even the simplest of tasks in aircraft maintenance can be dangerous. When things go wrong how can we prevent a bad situation to become even worse? Let's start with a little story that happened to me while deployed on a *Sea King* helicopter air detachment (Helairdet) and then we can examine how can we prepare for the worst.

One day while embarked on a Her Majesty's Canadian Ship (HMCS) off the coast of the southern United States, we had to carry out a fuel quantity system calibration once flying was complete to verify the system's state. In order to do so, the system had to be drained completely. After defueling, we got ready for 'dripping', which is basically getting rid of the remaining fuel (that could not be defueled by the ship's fueling system) by using the sump drain valves. The whole detachment was in the ship hangar and we were all busy carrying out different maintenance tasks. Three technicians were assigned to drip the fuel tank and they had all they needed to carry out the task. Buckets, lots of diapers, rags, and tools etc.

Shortly after the team started dripping things went wrong. Normally, drain valves open and close quite readily. That way you can keep control of the operation. This time, the drain valve got stuck in the open position and it would not budge. Things happened quickly from there. The personnel underneath the aircraft hastily told us the valve was stuck and that they would need some help. It became obvious that we needed more than a few buckets to control the free-flowing fuel. When fuel is spilt on a ship, the fuel can easily find its way overboard.

We raised the alarm and quickly the ship's hazardous materials (HAZMAT) team arrived along with the ship's firefighters. In the meantime, we gathered more buckets, diapers and all the spill kits we could muster. We had to store that fuel somewhere and fast because we were running out of buckets. We started to dump it in a small HAZMAT garbage can, but found out quickly it was leaking. We ended up using a HAZMAT barrel. By the time we managed to close the valve, we had three fuel-soaked technicians (taking turns trying to shut down the valve), and a HAZMAT barrel full of jet propellant 5. Luckily, there were no injuries (just skin irritation), no fire and no fuel in the ocean. How did we do it? The following factors will help explain how we made it through this situation with limited impact.

### Due diligence.

First, the team who was carrying out the maintenance had all the equipment needed to contain a small spill had the need arise.

### Experience.

The reason they were so well prepared is probably because the experienced crew knew that you cannot trust a fuel drain valve on a *Sea King*.

If your knowledge is limited on a system, go ask the experienced personnel of your crew. You might have to listen to their *Twin Huey* or HMCS *Bonaventure* stories but it might save you from trouble.

### Do not hesitate to ask for help when needed.

Having the help from the ship's company and knowing the firefighters were monitoring us contributed to the overall response.

### Know what to do in case of an emergency.

There is a reason the HAZMAT team showed up so quickly as the alarm was raised in no time.

### Teamwork.

The final factor that made a difference was the team work. Most members of our Helairdet had been working together for quite some time already and they worked very well as a crew.

Looking back at that incident, if you take out any one of the factors above, the outcome could have been very different. Due diligence, experience, knowing when to get help, knowing what to do in case of an emergency and teamwork all played a part in this successful response. This story equally reminds us that there is no routine task in aviation maintenance.

Photo: Cpl Eric Girard


Photo: Cpl Gayle Wilson

# A Premature Assumption

by Second Lieutenant Kailee Garfield, Royal Canadian Air Cadet Operations, Atlantic region

Flight Safety is something that every member of a flying operation is responsible for maintaining. This is a phrase that I have heard countless times since first receiving my glider pilot's license at the age of sixteen. While this phrase is always in the back of every pilots mind, sometimes it takes an occurrence, incident or accident to truly understand how every member of the aviation community contributes to a safe and successful flying operation.

It was during my second summer as a flight instructor in which I experienced the most memorable flight safety incident of my career. After completing his pre-flight inspection, my student hopped into the glider and began his pre-take off checks. During this routine process my student noticed that when he pulled on the tow rope release mechanism, it seemed to have an insufficient amount of tension. As the instructor in charge of the mission I addressed his concern and pulled on the release myself. This aircraft had an older mechanism in comparison to the other gliders and I believed that the difference in tension was a result of aged wear. After verifying the release for myself I felt confident that the student, someone whom was consistently nervous prior to take off, was accurate in his observation but that there was still sufficient tension to proceed with the flight.

At approximatively 200 feet above ground level, a loud noise was heard by both myself and my student and we quickly realized that we were no longer attached to our tow rope; the mechanism had let go. While watching the tow plane fly away in front of me, I quickly took control of the aircraft from my student and assessed our situation. With nothing but trees in front of us and on either side of the glider I opted to utilize the remaining momentum from our increased airspeed while on tow and performed a steep turn 180 degrees in the opposite direction. Barely making the landing area the aircraft landed on the runway without damage and without injury to anyone involved.

For many this may sound like a rather insignificant experience, however, as a glider pilot taking into consideration the landscape of the airfield this was a grey area altitude.

Once on the ground I was approached by multiple superiors who congratulated me for my sharp thinking and for a job well done. Through all of the congratulations all I could think of was my student's initial observation. My own complacency and sense of urgency had put us in an unsafe position and I had failed in my responsibility to ensure a safe learning and flying environment.

As is the case with any flying operation, efficiency is important. In this particular instance I mistook my student's concern for nerves, I did not pay an appropriate amount of attention to addressing his concern and for the sake of efficiency I did not do a visual inspection of the mechanism. This occurrence is what truly reinforced to me that Flight Safety is everyone's responsibility. When we as individuals make mistakes it is our duty to verbalize them so that others can learn from our errors. Pride has no place in Flight Safety. Through this experience I learned to be more diligent with my student's concerns and can say with great certainty that on that day the teacher became the student and I was taught a lesson that I will never forget.

# Could Have Been Worse

by Master Corporal Carl Portman, Search and Rescue Technician, 435 Transport and Rescue Squadron, Winnipeg

We were a CC130 *Hercules* Search and Rescue (SAR) crew doing night water training over Lake Winnipeg. The other SAR technician and I had just finished getting dressed to conduct a full equipment parachute descent to the water. Our safety checks were complete and we were ready to go.

The Loadmaster (LM) asked to switch communication cords with me as we were both using cords from opposite side of the cargo compartment. This made sense and he plugged me in, coiled up the cord he gave me and dropped it on the floor. I knew I should pick up that cord and place it off the floor, but I was tired and uncomfortable from wearing 45 kg of extra gear. I couldn't see well because it was dark and the swim fins I was wearing made it hard to move around. I made a mental note to confirm my legs were clear prior to leaving the aircraft.

As I was observing the LM and Air Combat Systems Officer having difficulty managing the flares, the Team Leader (TL) wanted me to look at the target one last time. Soon after, the pilots were confirming jump altitudes and in a short matter of time I was one minute back from the jump and I had forgotten all about my communication cord. I hung my headset up on the railing between the left-hand parachute door and LM seat, donned my helmet and goggles and got ready. The TL signalled to exit and as I stepped off the ramp I felt something tighten around my right ankle. "Oh crap!" I thought. Time stopped long enough for me to think about what could be around my leg and the most likely culprit was the communication cord. This was also the best case scenario

because anything else would have likely resulted in a career ending, life threatening injury.

The tension increased and suddenly released confirming to me that it was a communication cord (nothing else would break so easily). This caused me to flip through my parachute lines and get caught in them. There I was, upside down, tangled in lines with all this equipment on, at night and over water. After a brief assessment, I managed to get everything sorted out and land without further incident. It could have been much worse.

It would've taken 20 seconds of time to police that communication cord or I could have asked another crew member to do it; so why didn't I? Fatigue leading to complacency perhaps. For one, I did not utilize the rest period prior to the start of my duty day which started at 16:30. Instead I ran a physical fitness test and then prepared training gear for three hours. Fast forward to 22:00, which is the time we left the aircraft, and unsurprisingly I was more tired than I should have been. I was complacent in the sense that I knew that communication cord was a tripping hazard and it needed to come off the floor but didn't take care of it right away. I subsequently got distracted and forgot about it.

***"It would've taken 20 seconds of time to police that communication cord or I could have asked another crew member to do it; so why didn't I?"***

Follow the rules regarding rest periods whether they are prior to duty or after flying. Be disciplined in the conduct of your duties and keep your situational awareness on top of things, especially at night.

Photo: Cpl Neil Clarkson


Photo: Cpl Darcy Lefebvre

# From the Investigator

**TYPE:** CC130608 *Hercules*
**LOCATION:** Resolute Bay, NU
**DATE:** 18 March 2015

The occurrence aircraft was a CC130J *Super Hercules* transport aircraft operated by 436 Transport Squadron out of 8 Wing, Trenton, Ontario. The mission to Canada's far north was in support of Operation NOREX – an exercise aimed at confirming the military's ability to operate in the northern environment.

The occurrence aircraft with a crew of four was transporting five pallets of equipment and supplies and twenty one passengers from 8 Wing, Trenton, ON to Resolute Bay, NU. The flight to Resolute Bay airfield (CYRB) was uneventful and the aircraft landed on runway 35T in good weather conditions at 11:01 local (L) time. With only one mid-field taxiway to exit the runway, the crew backtracked in a southerly direction and exited westbound on Alpha taxiway.

Due to a CC177 *Globemaster III* which was occupying the main ramp and scheduled to depart within two hours, the CYRB radio operator directed the *Hercules* crew to park on the northern Polar Shelf apron. Approaching Bravo taxiway which leads to the Polar Shelf apron, the crew asked the CYRB radio operator to confirm the feasibility of taxiing a Hercules aircraft to that location. After receiving confirmation from the CYRB radio operator that many *Hercules* and Boeing 737 aircraft had previously taxied to that location on the airfield, the first officer (FO) who was the pilot flying (PF) and occupying the left seat for this leg of the mission, proceeded to steer the Hercules northbound on Bravo taxiway.

Having identified obstacles to the left which consisted of light poles and a storage shed, the Aircraft Commander (AC) directed that the FO taxi towards the right side of the taxiway. While taxiing on Bravo taxiway, the radio operator called to report that he believed the aircraft had struck a light post. The FO then looked out at the left wingtip to see it making contact with another object, a storage shed, and the aircraft was brought to a stop.

After considering the predicament and confirming that the wingtip was now clear of the storage shed, the AC elected to continue taxiing to the Polar Shelf apron. The aircraft was parked, the engines shut down and the crew unloaded their passengers and cargo, terminating the mission. Later, the assessment of the damage to the structure on the outer two feet of the left wing was classified as C category damage.

The investigation is focusing on human and organizational factors that may have played a role in this accident.

Photo: DND

Photo: DND

# Epilogue

**TYPE:** CH146491 *Griffon*
**LOCATION:** 1 NM South of Cobourg, ON
**DATE:** 17 June 2011

A Transport and Rescue CH146 *Griffon* helicopter crew planned to conduct night boat hoist training near Cobourg, ON, with the Canadian Coast Guard Ship *Cape Mercy*. The aim of the mission was to conduct currency training for the SAR Tech Team Member and to provide the First Officer (FO) with his night boat hoist qualification.

Once in the vicinity of the *Cape Mercy*, the crew transitioned the helicopter to a 30 foot hover. The helicopter then inadvertently began to drift rearward and upward, reaching a height of 70 feet. A gradual correction back down was initiated but at approximately 35 feet, they again started to drift rearward and the FO, who was the flying pilot, suffered a loss spatial orientation. Perceiving that the helicopter was still descending and concerned with their height over the water, the FO raised the collective. This resulted in a low rotor tone and the helicopter's radar altimeter was observed to indicate 30 feet while the mast torque indicated 110%, 10% above its maximum allowable. The FO reduced the collective but maintained the mast torque above 100% to initiate an overshoot. Once established in a safe regime of flight, the crew aborted the training mission and returned to Trenton without further incident.

Following the occurrence, the operational community updated the formal risk assessment of Griffon operations in the low-level, over water environment and proposed risk-mitigating control options.

To determine why the over-torque occurred, the investigation reviewed the procedures for low level over water operations and focussed on training guidance, crew actions, the environmental conditions under which the night boat work was conducted and standard pilot monitoring duties and RADALT setting procedures during the transition to the hover. The investigation also highlighted the Griffon systems and equipment issues and the risks associated with regards to operating the Griffon in the low level over water environment.

The investigation concluded that this incident was the result of pilot inexperience, inadequate training and poor in-flight pilot monitoring procedures during an extremely challenging manoeuvre in a helicopter that was not optimally equipped to operate in the difficult, low-level, over water environment at night.

The investigation's final recommendations address the auto-pilot system, the radar altimeter warning system and current setting procedures. Additional recommendations included the creation of dedicated Griffon SAR Aircraft Captain and First Officer Qualification Standards and associated Training Plans, increased training requirements, a re-evaluation of night boat hoisting within the current over water capability of the Griffon SAR community and the formulation of long term plans to address the current platform limitations with respect to Canadian SAR region mission requirements.

# Epilogue

**TYPE:** CH149906 *Cormorant*
**LOCATION:** Kamloops Airport, BC
**DATE:** 7 August 2013

Helicopter CH149906 was conducting a normal take off to a 10 foot hover. Three seconds into the take-off, at approximately three to four feet above ground, the crew heard a clunk followed by «Master Warning» and «Engine Fail» tones. As the helicopter yawed slightly, the Flying Pilot briefly paused his application of power before slowly reducing it as the aircraft settled back onto the runway. The torque on No. 2 engine indicated zero and the Turbine Inlet Temperature was high at 1115 °C. A No. 2 engine emergency shutdown was then conducted before the helicopter was taxied back to the ramp and shut down.

A boroscope inspection confirmed damage to the No. 2 engine downstream of the second stage compressor. The engine was then routed to the third line contractor for a comprehensive teardown inspection with oversight from the engine original equipment manufacturer (OEM). The teardown found two adjacent airfoils on the second stage compressor bladed disk that separated at the root, causing secondary damage to engine components downstream in the gas path. The airfoils were not recovered, but the remaining bladed disk fracture surfaces clearly indicated signs of fatigue.

The investigation identified non-typical airfoil rub against the engine casing to be the most likely cause of the high amplitude fatigue that led to the crack initiation. Once initiated, the crack propagated under normal high cycle fatigue loading until failure. The investigation could not determine the exact conditions causing the non-typical rub, but two conditions may have contributed to such rubbing events: first, the tighter clearance of stage-2 Blisk replaced at third line maintenance, and second, the location of the engine on the airframe.

The principle safety recommendation called for all CH149 engine compressor casings to be refurbished so that adequate clearances exist between bladed disk edges and engine casings. Additionally, it was recommended that the planned ground and flight testing on CH149 airframe be used to document potential variances between the various engine positions which would explain damage found in this occurrence.

Photo: Cpl Daisy Hiebert

Stage-2 bladed disk with missing airfoils

Photo: Cpl Daisy Hiebert

Engine compressor

# Epilogue

**TYPE:** Cessna A150L
**LOCATION:** St-Hubert, QC
**DATE:** 12 July 2014

The Cessna A150L, registration C-FFIW operated under the Cadet Power Scholarship Program was doing touch and go landings at the airport in St-Hubert (CYHU) with only the student pilot on board. During an approach to runway 24L, the pilot decided to perform a go-around. At about 0.5 NM from the departure end of the runway, the aircraft stalled and crashed into the yard of a private home in a residential neighborhood just west of the airport. The aircraft sustained major damage. The pilot received minor injuries.

The investigation revealed no abnormalities with the aircraft. The flaps were found to be in the 40° position when the investigators arrived on scene. The "overshoot/go around" procedure required the flaps to be raised to the 20º position. The examination of the flaps has established that they were operating properly. Analysis of the ATC recordings revealed that the Cadet was communicating with the "tower" from the time that the "overshoot" was called up until communication with the aircraft was lost prior to impact.

The investigation determined that the Cadet's attention was channelized on communicating the pilot's intention (i.e. overshoot) to the "tower" rather than applying all steps in the "overshoot/go around" process such as changing the flap setting from 40 degrees to 20 degrees. This resulted in a stall situation in the low level environment, leaving insufficient altitude for the recovery.

Photo: DND


Photo: DND

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