National Defence Défense nationale

ISSUE 3 2006

Flight Comment

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Canada

CAS Views On Flight Safety

By Lieutenant General J.S. Lucas, Commander of Air Command and Chief of the Air Staff

On 16 May 2005 I assumed command of Air Command and duties as Chief of the Air Staff. Since that time, I have had the opportunity to interact with many members of the Air Force. These interactions have reinforced my pride in our Air Force and the exceptional people we have doing a very professional job. At the same time, I know that we have had our share of significant challenges. But we have the tools to meet these challenges — such as our outstanding Flight Safety program complemented by a new Airworthiness Program.

In my talks with other Air Forces' Commanders and senior staff, I concluded that our flight safety program and our flight safety culture are the envy of many militaries. I view the Canadian Forces flight safety program with much pride given the strong pillars it is built on. Firstly, the maturity of the philosophies of sharing and learning, of no-blame, of open and honest reporting, and of anonymous reporting translates to getting "good" information from the field and thus a "good" response from leadership. Secondly, the development of a deep, searchable, widely available electronic database such as our Flight Safety Information System is highly desired by other Forces. Thirdly, this magazine — *Flight Comment* — goes to 40+ countries with more requests coming in all the time. It is recognized internationally as a provider of high quality, high relevancy flight safety information. And lastly, the broad buy-in from all levels of the CF, from all occupations, and from all agencies, including civilian DND employees, Original Equipment Manufacturers and civilian contractors, creates a well focused team, playing off the same play sheet and all pulling in the same direction.

The flight safety program has been around since the 1950s. When I began my career as a line navigator in the early 1970s it was already a mature program. I saw the program as a safety tool. It was a way to keep myself, the crew and the aircraft safe during the mission so that we could return home alive, to fly another day. Flight safety was a series of checks, SOPs, procedures, and inspections, all designed for self-preservation. As my career progressed, I was no longer in the aircraft or on the floor, but I still saw the program's necessity in achieving the mission and to bring you and the aircraft home safely. Flight safety became a force multiplier, a mission enabler. I also see it as a risk management tool that permits achievement of the mission yet preserves scarce assets.

A recent complement to the flight safety program is the Airworthiness Program. The Minister of National Defence (MND) is legally responsible for all aspects of military aviation including the development, regulation, operation and supervision of all matters related to military aeronautics. An Airworthiness Program (AP) has been mandated to ensure the airworthiness and safety of all aspects of military aviation. The MND has delegated the Chief of the Air Staff as the *Airworthiness Authority* (AA) with the responsibility to supervise and manage the AP.

The AP has three main components: the first is the Technical Airworthiness Program, which regulates all aspects of the design, manufacture and maintenance of our aeronautical products. DGAEPM undertakes these responsibilities as the *Technical Airworthiness Authority* (TAA). The second, the Operational Airworthiness Program, regulates all aspects of the operation, procedures, flight standards, operator training/qualification/licensing and Aerospace Control of our aeronautical products.

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Challenger pushback in Ottawa.
Photo: Corporal Éric Jacques

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THE CANADIAN FORCES FLIGHT SAFETY MAGAZINE

Flight Comment is produced three times a year by the Directorate of Flight Safety. The contents do not necessarily reflect official policy and unless otherwise stated should not be construed as regulations, orders or directives. Contributions, comments and criticism are welcome. Contributions become the property of *Flight Comment* and may be edited for content, length or format.

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Annual subscription rates: for Canada, $19.95, single issue, $7.95; for other countries, $19.95 US, single issue, $7.95 US. Prices do not include GST. Payment should be made to Receiver General for Canada. This publication or its contents may not be reproduced without the editor's approval.

To contact DFS personnel on an **URGENT** Flight Safety issue, please call an investigator who is available 24 hours a day at 1-888-WARN-DFS (927-6337). The DFS web page at www.airforce.forces.gc.ca/dfs offers other points of contact in the DFS organization or write to dfs.dsv@forces.gc.ca.

ISSN 0015–3702
A–JS–000–006/JP–000
Art Direction: ADM (PA) DMCS
CS05-0274

Good Show

For Excellence in Flight Safety

This award recognizes the outstanding contribution and teamwork displayed by fifteen members of 423 Maritime Helicopter (MH) Squadron on 5 Nov 2003. Specifically they are Master Corporals Bond, Goodall, Kay, Kuesler, Penney, Piercey and Sooley, and Corporals Blackwell, Eddy, Knowles, McNamara, Parfitt, Ruel, Steffin, and Westlake.

While towing *Sea King* CH124410 into F Hangar at 12 Wing Shearwater, the tow crew members noticed smoke emanating from the engine intake area of aircraft 426 which was positioned in the center of the hangar. Without hesitation, the tow crew, with the assistance of other technicians in the area, immediately alerted maintenance personnel working within aircraft 426 of the emergency. In addition, the verbal warning of "Fire, Fire, Fire" and the activation of the pull station fire alarm were actioned.

Two technicians acted swiftly to secure aircraft power, while another technician climbed up to the engine compartment where he immediately commenced fighting the fire with an extinguisher. Key individuals also stepped in to "flake out", charge and ready back-up fire hoses for action. With technicians fighting the fire on top of aircraft 426, additional personnel took up towing positions to traverse aircraft 410 out of the hangar entrance. Once the fire was extinguished, aircraft 426 was towed and positioned on the ramp where arriving fire department personnel could monitor and assess the situation.

Much of their response and training is borne from the in-depth instruction they receive as part of any air detachment deployed on ships. Five of the six 423 (MH) Squadron Sea King helicopters were, at the time, blocked in the hangar by the incident aircraft. The immediate response, superior skill, and courage demonstrated by these fifteen determined technicians was instrumental in controlling this situation and preventing further damage to 423 (MH) Squadron personnel and resources. ◆

From left to right: Sgt Piercey, Sgt Goodall, Sgt Sooley, Cpl Parfitt, Cpl Knowles, MCpl Kay (now retired), Cpl Ruel, MCpl Penney and MCpl Steffin. Not present in the photo are MCpl McNamara (now retired), Sgt Bond, MCpl Kuseler, Cpl Eddy, Cpl Blackwell and Cpl Westlake.

Good Show
For Excellence in Flight Safety

Warrant Officer Bruno St-Laurent

In support of land force exercises in Wainwright, Alberta, 430 Tactical Helicopter Squadron had just completed a night heliborne mission with twelve CH146 *Griffons*. Following that mission, three crews, including Warrant Officer St-Laurent's, were preparing to transport artillery crucial to the supported forces' tactical plan. While the three helicopters were being readied, WO St-Laurent noticed that one of the three aircraft was manned, had navigation and anti-collision lights on, and was preparing for take-off. Though very dark, WO St-Laurent looked toward the tail of the aircraft and observed that the tail rotor was still fastened. He immediately alerted the flight engineer of the aircraft in question who disembarked and freed the rotor.

WO St-Laurent's alertness, perception of a threat, and quick action in addressing that threat prevented serious damage to the aircraft and kept an essential operational asset on the line and supporting the work of the Canadian Forces. ◆

Master Warrant Officer Bruno St-Laurent is serving with 430 Tactical Helicopter Squadron, Canadian Forces Base Valcartier.

From Bottle to Throttle or Schooner to Spanner

Research shows the lingering impact of alcohol on performance

By Lieutenant Colonel Peter Murphy, Staff Officer Grade 1 (SO1) Aviation Psychology, HQ 16 Brigade (Aviation) Oakey, Queensland, Australia

"Drink... provokes, and unprovokes; it provokes the desire, but it takes away the performance."

—William Shakespeare, Macbeth, Act 2, Scene 3

An emphasis on blood alcohol level in measuring human performance has masked a vital issue about alcohol use: its lingering impact on performance, even after blood alcohol content has returned to zero. This issue has been addressed in the new [Australian] Defence Instruction (General) on Temporary Medical Unfitness for Flying (TMUFF) by extending the 'bottle to throttle' rule from eight to twelve hours. In safety-critical occupations such as aviation, optimum performance is not just a goal; it is an ethical and professional imperative.

Four hundred years ago, in Macbeth (1606), Shakespeare observed that alcohol increased confidence while lowering performance. Few adults would dispute this insight, but a long–standing challenge in our society has been how to measure the impact of alcohol on performance.

In the early decades of the motorcar, in order to determine degree of alcohol impairment, police used indicators such as the smell of alcohol on the breath, the slurring of words, poor mental arithmetic, and the ability to walk a straight line. Such measures were obviously imprecise and less than ideal.

The ability to measure blood alcohol content using breathalysers and blood sample analysis has brought some precision to the challenge of measuring alcohol impairment. However, these methods have been driven, and to some extent overtaken, by legal considerations and a perspective that some degree of performance degradation was permissible whilst driving a motor vehicle.

In safety-critical professions, such a perspective is inappropriate and unacceptable. Optimum performance must be the goal, not the extent to which performance decline is acceptable. Recent [Australian] DFS-ADF accident investigations have revealed that the final active failure in some accident sequences has been the result of a moment of indecision or a lack of alertness. In some of these accidents, the subtle, lingering impairment of performance due to alcohol consumption could not be ruled out as a contributing factor to these active failures.

This is not to say that the aircrew involved were alcoholics or that they had failed to comply with alcohol ingestion instructions at that time. All aircrew tested in recent accidents have registered a Blood Alcohol Level (BAL) of zero in post-accident toxicology tests.

"Aviation in itself is not inherently dangerous. But to an even greater degree than the sea, it is terribly unforgiving of any carelessness, incapacity or neglect."
(Attributed to Captain Lamplugh, British Aviation Insurance Group, London circa 1930s)

However, as the recent Defence Instruction on Temporary Medical Unfitness for Flying (OPS 22-2, dated 16 March 2004) notes: "Even after BAL has returned to zero, (the effects of alcohol) can result in marked impairment of performance for reasons including dehydration, hypoglycaemia, gastrointestinal upset and disturbances in the vestibular system" (p. A-2).

The reduction in performance due to alcohol after BAL returns to zero is known as 'post-alcohol impairment'.

As the above quote and many accidents attest, aviation is unforgiving of any incapacity. Alcohol ingestion contributes to lowered performance — in other words, a degree of incapacity. Recent research has shown this impact on proper functioning to last longer than previously assumed.

The extension of the 'bottle to throttle' rule in OPS 22-2, from eight hours to twelve hours, is a response to research proving that performance is adversely impacted by alcohol ingestion well after BAL returns to zero. It is notable that OPS 22-2 states: "The so-called 'bottle to throttle' rule is not an accurate indicator of fitness to fly after drinking alcohol," (p. A-2) because even twelve hours may be an insufficient buffer.

Smart aviators would not dispute that functioning at their best is a key insurance against errors and accidents. What many members of Defence aviation may not have realised are the enduring effects that alcohol can have on performance.

Several recent studies have indicated that pilot performance can be measurably impaired for at least eight to fourteen hours after last alcohol ingestion. These performance deficits are apparent across a range of psychomotor and mental abilities and include slowed reaction time, lowered vigilance, difficulties processing radio communications, disruptions to the formation of new memories, and impaired judgment in activities such as determining angle of bank and rate of turn. Many of these deficits have implications for performance across the aviation capability, including maintenance tasks and air traffic control.

For aircrew, a group of sensory-perceptual hazards related to post-alcohol impairment are the vestibular illusions, for instance, the 'G-excess' illusion. The G-excess illusion generates a false sensation of body tilt. It is usually invoked when head movements conflict with the relative motion of the aircraft. Attempts to cor-

rect for the sensations caused by the illusion may cause the pilot to over-bank the aircraft and descend. Many spatial disorientation accidents have been attributed to the G-excess illusion, especially those involving high-speed, steeply banked turns at low altitude, and those involving sharp turns in blackout night flying conditions. Research has demonstrated that perceptual errors of 5-10 degrees can be generated at 1.5 G, and perceptual errors of 10-20 degrees at 2 G (Gillingham & Previc 1996).

Vestibular illusions are known to be more pronounced if the person is under the influence of alcohol. Furthermore, the vestibular system is particularly prone to post-alcohol impairment (Gibbins 1988). Susceptibility to G-force induced vestibular dysfunction has been shown to persist up to 48 hours after the intake of alcohol. Some basic physiology helps to explain this persistence.

The semicircular canals and the otolith organs in the inner ear are responsible for balance and detection of movement. These organs are filled with a fluid called endolymph that moves over hair-like sensors that assist the brain in perceiving motion. When alcohol is absorbed into the endolymph, it lowers its specific gravity. As a result, the endolymph fluid moves more readily, which the brain interprets as excessive movement. This is the reason why people under the influence of alcohol stagger and sway. Even after blood alcohol is reduced to zero, it takes many more hours for the

alcohol to be absorbed out of the endolymph. Until the specific gravity of the endolymph returns to normal, the individual will be subject to exaggerated vestibular effects.

The collective results of post-alcohol impairment are variable and diminished performance, and increased error. Overly optimistic assessments of ability (Shakespeare's 'provoked desire') have also been found, which can indirectly lead to performance failures.

Many post-alcohol impairment studies used a target BAL of 0.10 for participants. If an even higher BAL was reached, the persistence of adverse performance effects is likely to be exponentially longer than the fourteen hours actually observed in some subjects. Indeed, one RAAF Force Element Group (FEG) has TMUFF guidelines that prevent flying duties for eighteen hours after seven standard drinks, thirty hours after eleven standard drinks, and forty eight hours for twenty or more standard drinks. These guidelines are a sensible approach to acknowledging and managing the persistent effects of alcohol ingestion. ◆

This article was printed with permission from Aviation Spotlight. *It originally appeared in the 0404 edition.*

A comprehensive review of these studies of post-alcohol impairment is included in an article by Dr David Newman: Alcohol and human performance from an aviation perspective: A review. *The article was published [in 2004] and can be accessed at the Australian Transport Safety Bureau (ATSB) website: http://www.atsb.gov.au/public/discuss/alcohol.cfm.*

Continued from page 1…

The Commander of 1 Canadian Air Division has these responsibilities as the *Operational Airworthiness Authority* (OAA). The third, the Airworthiness Investigative Program, regulates all aspects of the flight safety program including education, promotion and accident/incident investigation and reporting. The Director of Flight Safety (DFS) carries these responsibilities as the *Airworthiness Investigative Authority* (AIA).

I rely on DFS as the AIA to investigate aviation safety matters and to monitor the airworthiness program. The independence afforded by DFS ensures the integrity of the advice and the reliability of investigative findings/recommendations received from the AIA. It is important to note that both the Flight Safety and the Airworthiness programs are but a shell: we need our greatest asset — the airwomen and airmen who are the Canadian Air Force — to embrace and actively participate in them both.

During my 36-year career, the CF and the Air Force have endured some challenging years. Yet the importance of Flight safety remains a constant source of pride for the Air Force. Flight Safety has different meanings for each of us — whether a method of self-preservation, a force multiplier or an essential arm of the airworthiness triad. But I want to take this time to encourage each member of the Air Force to participate in, and to buy into, the Flight Safety Program. It is this participation that has made it work for over 50 years. That is something that gives me much pride, a pride that you should share. ◆

The Editor's Corner

History Sucks!

When asked their opinions on the subject of history, this was, and is, the prevailing attitude of high school students. I'm still not a great fan of the subject. I think too many believe that history is a window on the future. (How's that for a feedback getter?) A study of history couldn't predict computers, the atom bomb, AIDS or global warming (some still don't accept it), but history is an incredible illuminator of human error. History didn't point to the cell phone, but whether distracted by the functioning of the Cotton Gin or your latest MP3 ring tone, humans get distracted and sometimes have accidents.

As I write this, our flight safety database contains 115,563 occurrences. I'll go out on a limb here and guarantee that no future aviation accident will differ in cause than that of those accidents and incidents we have already investigated and recorded. I hear you saying, "But Rob, what about new technology like the UAV? There's gotta be different problems!" And that seems logical, except we have now done several investigations involving the UAV and the causes come down to "part failed", "insufficient operator training", "weather/environment", "complacency", etc.… If it was designed, manufactured or operated by humans, the errors will be the same. Whether human engineering or human knowledge, in interaction with other humans or machines, the causes will be therein.

So, how do we use our knowledge and database to prevent aviation occurrences? After all, that is the role of flight safety! Well, up until two years ago, DFS didn't have anyone dedicated to analyzing the database, and only now are we getting all the tools in place to help in analysis and trending. That's a start, but we know that we have to do more. We — DFS — will soon gather to determine a strategy for the future direction of our efforts to preserve aviation assets — people and equipment.

In the meantime, check out our new regular column — "Check Six: Plumbing the Back Issues of *Flight Comment*". You're also invited to read the article by Major (Ret'd) Jim Burger who wrote his article just before leaving DFS and to look at the article about the changes we've made to the A-GA-135, *Flight Safety for the Canadian Forces.*

Finally, as I look back at my high school years, I now realize history was a pretty decent subject — it was economics that really sucked! ◆

Corrections: In Issue 2 2006, credit for the photo of the *Harvard* on the cover is deserved by Mr. Ken Lin. On the French side of the same issue, Private Walton was incorrectly referred to as Private Watson in his For Professionalism award.

Terminal Arrival Areas (TAAs)

By Major Kevin McGowan, United States Air Force exchange officer, Central Flying School, 17 Wing Winnipeg

Like many other industries, the aviation industry is in a state of perpetual change: over the course of the last 102 years, we've progressed from the invention of powered flight to supersonic travel. Furthermore, navigation techniques and tools have evolved from dead reckoning with a stop watch and map reading to laser ring gyros and Global Navigation Satellite System (GNSS) capabilities with the capacity to fly approaches down narrow, curving mountain canyons in instrument meteorological conditions (IMC) to 250' AGL. To help take advantage of this new technology, effective 27 October 2005, Canada has adopted the Terminal Arrival Area (TAA) procedures that have been widely used in the U.S. for several years now, and they will be slowly integrated into the NavCanada approach inventory.

So, what are TAAs anyway? Simply put, TAAs are efficient arrival procedures that are designed to get the pilot down from the enroute structure to the underlying area navigation (RNAV) approach procedure with very little ATC interaction. Although TAAs are not present on all RNAV approaches, especially in heavy traffic areas, they do provide progressive step-down altitudes for the pilot to fly based upon the aircraft's relative position to the respective sector's initial approach fix (IAF) (not a navigational facility).

Identifying a TAA

Although more critical in the U.S. due to different terminal arrival procedures, identifying which RNAV approaches have TAAs and which do not is absolutely critical. Luckily, identifying the difference between the two has been made remarkably easy through a slight variance in minimum safe altitude (MSA) depictions.

Traditional instrument approach procedures (IAPs) have 360° MSA circles depicted in the IAP's plan view that extend out 25 nm from the approach facility (or missed approach waypoints on RNAV approaches) and may be divided into sectors of no less than 90° (see *Figure 1*). The MSA circles on TAAs are broken into multiple pie-shaped wedges that extend 30 nm from the IAF (not an aerodrome facility) for the respective sector on the underlying RNAV approach. Each wedge is separated from the other and is placed in the corresponding sector of the IAP's plan view (see *Figure 2*).

RNAV IAP Layout:

The RNAV procedure underlying the TAA will normally be in a standard "T" design (also called the "Basic T") (see *Figure 2*). If required for terrain clearance or air traffic control considerations, the procedure may also assume a "Y", "L" or "I" shape (see *Figure 3*). The approach will typically have one to three IAFs; an intermediate fix (IF), which will also serve as one of the IAFs; a final approach fix (FAF); a missed approach waypoint (MAWP), which will be typically located at the runway threshold; and a missed approach holding point (MAHP). All the waypoints on the approach, except the MAWP, if co-located with the runway threshold, will be given a "pronounceable" 5-letter name which will be in your FMS database. The IAFs are typically aligned in a straight line, perpendicular to the final approach course, thus forming a "T". The initial segment is normally 3 – 6 nm in length; the intermediate segment is typically 5 – 7 nm long; and the final segment is typically 5 nm long with the actual lengths of each segment being dependant upon the surrounding obstacles / restrictions and the highest category of aircraft normally expected to use the procedure.

Although RNAV approaches are typically designed to eliminate the need to perform a procedure turn, this isn't always possible. When required for altitude loss (usually due to excessively steep descent gradients on the approach) or alignment purposes, the TAAs may include a holding pattern co-located with the IF (known as a holding-in-lieu-of (HILO) procedure turn when flying

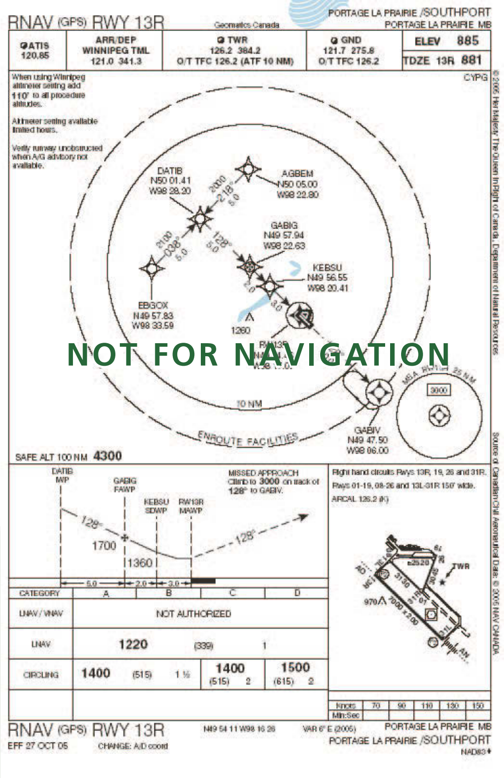

Figure 1

Figure 2

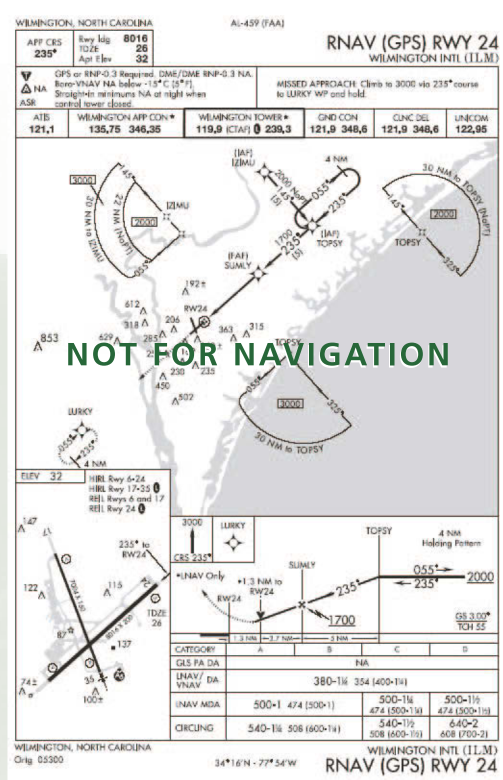

Figure 3

Graphics obtained from the FAA FAR/AIM, and the DND and DoD FLIP.

in the U.S. or a "racetrack" procedure when flying overseas) (see *Figure 2*). This mandatory holding pattern will be depicted with a dark, solid line similar to the actual approach routing. If so included, the arrival routing will be annotated with "NoPT" (no procedure turn) on the TAA entry sector wedges or the approach routing itself to identify when the holding pattern is not required. If arriving from a sector or routing that does not have "NoPT" depicted on it, the pilot is expected to execute one turn in the depicted holding pattern as an alignment manoeuvre followed by the remainder of the approach. Now, if the holding procedure is not required (i.e. you are entering from a "NoPT" sector or routing, or you've been vectored to final and "cleared for the straight-in approach" by ATC) but you choose to execute the depicted holding pattern anyway, you must inform ATC and receive clearance to do so beforehand.

Arrival Routing

The standard "T" design RNAV approaches are broken down into three areas: the left base, right base, and straight-in sectors. These areas are defined by the extension of the IAF legs and the intermediate segment course and extend out to 30 nm from the defining IAF appropriate for that sector (see *Figure 4*). The TAA's lateral boundaries are defined by magnetic courses to the IAF appropriate for that sector. The straight-in area can be further broken down by magnetic courses to the IF (IAF) and arcs based upon the RNAV distances from the IF (IAF). The left and right base areas, on the other hand, can only be further subdivided by arcs defined by the RNAV distance to the respective IAFs (see *Figure 2*). As of 23 February 2006, all sector altitudes provide 1,000' obstacle clearance and 2,000' in all mountainous areas.

OK, so how do you fly this thing? Once you're cleared for the RNAV approach, and prior to reaching the TAA, you'll need to determine which sector you'll be approaching from. You can do this by determining the magnetic bearing from your present position to the IF and comparing this to the bearings that are published on the TAA that define each sector (see *Figure 4*). It is essential that you use the bearing to the central IF and not the IAF for the left or right base areas. Using the incorrect IAF as a reference point may provide a false position which could result in you descending prematurely or to an incorrect altitude, flying incorrect routing, and/or incorrectly applying the IF holding alignment procedure if so annotated (i.e. flying it when you shouldn't or vice versa).

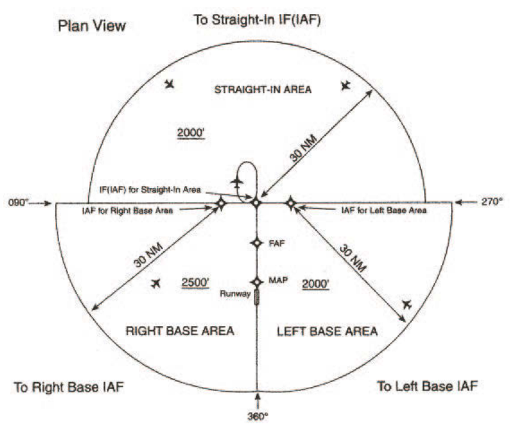

Figure 4

OK, so how do you get to the TAA in the first place? Luckily, TAAs typically overlay one or more airways from the en route system. In this case, fly the airway routing until established within a segment of the TAA (i.e. within 30 nm of your respective IAF) and then proceed directly to your respective IAF. In the event that the TAA does not overlie the airway, there will typically be a transition route published from the airway structure to the TAA. In the rare instances where there is no airway or transition route passing through the TAA, fly direct to your respective IAF and maintain the last assigned altitude (except in Canada where, unless told otherwise, you can descend to the lowest published IFR altitude for your position) until such time as you are established within the TAA boundaries.

Now once established within the TAA boundaries, you'll be expected to proceed directly to the IAF for your sector at the altitude(s) depicted on the TAA. This means that if you're in the left or right base areas, you will then proceed to the respective IAF for those areas. On the other hand, if you're in the straight-in sector, then you'll need to proceed directly to the IF (IAF).

As you're considered established on the approach once you enter the TAA area (or you're established on the transition route that will ultimately enter the TAA in the U.S.), you're expected to commence a descent to the respective step down altitudes. That means that if your respective entry sector contains step down altitudes (such as those depicted in *Figures 2* and *3*) and you're within the applicable subsection of the sector, you're expected to descend to, but no lower than, the step down altitudes depicted on the TAA unless instructed otherwise by ATC. This step down rule holds true in Canada as well as in the U.S. It is important to note that failing to reach the TAA altitude prescribed for your sector by the time you cross your respective IAF could result in a descent gradient for the remainder of the RNAV IAP that is in excess of an acceptable descent gradient (as prescribed by aircraft limits and/or terminal instrument procedures (TERPS) criteria).

Approach Routing

Upon passing the IAF for your respective sector at the altitude identified on the TAA, you'll be expected to complete the approach as depicted. Although your FMS/GPS should know what to do and fly it appropriately, it is important to understand what it should do so that you're not along for the ride to somewhere you shouldn't be. With this in mind, ensure that the RNAV approach is flown as depicted. Consider the approach routing a mandatory track that you must not deviate from. This includes all depicted courses and altitudes.

Once you're established on the initial and subsequent intermediate approach segment, then the remainder of the approach will be flown in accordance with established RNAV approach procedures.

Route Verification

Despite how wonderful technology is and how much we would like to trust it, it is critical that we not trust it 100%. The FMS/GPS database that contains the data for your route or approach was created by someone converting a textual version of the approach or routing into an apparently random string of letters and numbers that your FMS/GPS then interprets to be a specific route with specific altitudes or holding patterns. The process from conception to programming is an involved process that includes many individuals who are all susceptible to error. The problem is that if an error is introduced, that particular approach could become unsafe and/or ineffective. The catch is that you've got to catch it before it's too late.

To assist you with this process, your FMS database supplier (DoD or Jeppesen) will publish NOTAMs for their respective products. These NOTAMs will alert you to all known errors in their products. You can obtain the DoD DAFIF NOTAMs by clicking on the "DAFIF/Flip Chart Notices" button on the DoD NOTAM website (https://www.notams.jcs.mil) and the Jeppesen NavData FMS database NOTAMs by visiting the Jeppesen NOTAM website (http://www.jeppesen.com/wlcs/index.jsp?section=resources&content=notams.jsp).

Furthermore, in accordance with GPH 204A, before flying a GPS or RNAV IAP, you must verify the accuracy and integrity of the FMS database. This should be done by comparing the FMS version to a NOTAM-verified, current paper product. If any discrepancy is found, the paper product will be considered correct. It is also a good idea, although not required, to compare the FMS database to a paper product from another agency. For example, if you are using the Jeppesen NavData database, then compare the IAP to a DoD or DND paper version of the IAP. And while you can correct routing errors on preloaded standard instrument departures (SIDs) and standard terminal arrival routes (STARs), you are not authorized to change waypoint attributes (location, altitudes, etc.) on IAPs. This includes adding and/or removing waypoints from a preloaded IAP. You are, however, authorized to modify the attributes for the MAHP (such as defining a holding pattern) based upon clearances received from ATC.

Conclusion

So, there you have it. In a nutshell, TAAs are nothing more than a means by which ATC can get an aircraft down from the en route system onto an approach with minimal communication. Do a careful analysis of your present position before commencing the approach and then comply with the progressive step down altitudes outlined in your applicable TAA sector. Then, once you pass the appropriate IAF for the underlying RNAV approach, fly the remainder of the approach as depicted in accordance with established RNAV procedures.

Related Materials

At the time that this article was written, TAA criteria and procedures had not been included in the Transport Canada regulations. However, Transport Canada has adopted the FAA's regulations on TAAs by exemption as outlined in Transport Canada TP 308/GPH 209 Advisory Circular (AC)1/04 (Exemption From Paragraph 803.02(a) Of The Canadian Aviation Regulations). Although the initial expiration date on this exemption has already come and gone, the contents of the AC are currently being incorporated into the applicable Canadian regulations.

If you're interested in reading more about Terminal Arrival Areas (TAAs) and/or RNAV approaches in general, I would recommend reading Section 5-4-5 of the U.S. Federal Aviation Administration (FAA) Aeronautical Information Manual (AIM), which is available in print as well as online: http://www.faa.gov/airports_airtraffic/air_traffic/publications/atpubs/aim/Chap5/aim0504.html#5-4-5. If you're interested in the criteria for these procedures, I would recommend reading the following:

U.S. DoT FAA Orders

8260.3B Vol. 3, Change 19
Precision Approach (PA) and Barometric Vertical Navigation (Baro VNAV) Approach Procedures

8260.40B
Flight Management System (FMS) Instrument Procedures

8260.42A
Heliport Global Positioning System (GPS) Non-precision Approach Criteria

8260.45A
Terminal Arrival Area (TAA) Design Criteria

8260.47
Barometric Vertical Navigation (VNAV) Instrument Procedures Development

8260.48
Area Navigation (RNAV) Approach Construction Criteria

8260.50
Wide Area Augmentation System (WAAS) Instrument Procedures

8260.51
Required Navigation Performance (RNP) Instrument Procedures ◆

This article, as well as many other IFR related articles written by the CF Instrument Check Pilot Flight Staff are available online at http://www.icpschool.com/track.html. Furthermore, extensive flight planning resources are available online at http://www.icpschool.com/planning.html.

MAINTAINER'S CORNER

Spanner in the Works

Perceived pressure in maintenance

People often show substantial cognitive impairment when faced with serious stressors. They find it hard to concentrate and organise their thoughts logically. They may be easily distracted. As a result, their performance on tasks, particularly complex tasks, tends to deteriorate.

— Introduction to Psychology, *Eleventh Edition*

By Flight Officer Dane Petersen, 92 Wing, Australian Defence Force

Flight line, the pressure is on — or is it? It's the end of a long deployment, with only two aircraft to launch. Everyone is looking forward to heading home. The first aircraft departs without incident and, as the second taxies, the senior maintenance manager is relieved. The last week in particular has been a frustrating time, with high failure rates and long working hours; all the technicians are anxious for the stand-down.

Then, over the radio the room echoes with the words, "No radar, returning to lines."

Despite the inevitable delay, the flight crew depart the aircraft very eager not to stay another day. Knowing crew duty will soon become a factor for the transit home, they realise the fault will need to be rectified quickly. This thought, although not directly relayed to maintenance, is immediately felt by all flight line personnel. Suddenly the atmosphere changes: time is of the essence; the aircraft must get airborne today.

Work begins—this is a very professional and experienced maintenance team. Everyone knows their job, little communication is needed or used. The task is completed in quick time, all amid an air of effortless precision. Following the successful departure, the maintenance crew begin their stand-down checks of the section and paperwork. The maintenance manager calls for a tool board clearance only to learn that a tool is still tagged to the recently departed aircraft. The result? The aircraft is recalled, a PAN declared and Aviation Safety Occurrence Report (ASOR) action initiated. The investigation's key contributing factor? *Perceived pressure.*

What is perceived pressure?

Perceived pressure has been determined to contribute to numerous maintenance-related ASORs across the Australian Defence Force (ADF). ***So what is perceived pressure? It is, as the name suggests, the processing of stressors that need not or do not exist.*** As an example, the stress felt by child to succeed in an effort to make a parent proud.

For the ADF aviation technician, pressure is a normal part of the job; it is experienced and dealt with every day. The source of pressure is wide and varied; it can be clearly apparent or exist merely on a subconscious level. It will certainly affect each and every one of us in different ways. Typical causes are exposure to uncontrollable or unpredictable events, situations or tasks that challenge the limits of our perceived capability, and when the time afforded to perform or complete a task is limited.

Pressure in the workplace

Interestingly enough, stress and pressure in small and controlled amounts is known to improve job satisfaction and work output. However, when pressure sources are increased, the ability to deal with them tends to rapidly decrease, inevitably to a point where a person will become overwhelmed. Possible reactions to a stressful environment may include anxiety, anger, discouragement and depression, amid others. In the case of ADF aviation technicians, due to the inherent complexities involved in the majority of their tasks a highly pressured environment — and hence stressful situation — can reduce the ability to process information, which in turn can

Photo: Corporal Danielle Michaud

lead to distraction and even impatience. This is an extremely important point because as we enter these modes of thought, our capacity to distinguish actual from unnecessary or even non-existent pressure can and will be greatly weakened. To apply this thought practically, it is beneficial to think of the technician subjected to a pressure-induced paradigm.

Pressurised working environments and situations are an accepted part, in fact intrinsic to the military life. Consequently, the military as an organisation is 'established' to operate effectively under such conditions. Factors such as a defined leadership structure, a common training base, and set procedures for almost everything we do are all well established. However, it is when safety is paramount, such as in aviation, that these organisational factors assume particular importance. On the flight line they are implemented and employed without compromise. However, as per the Swiss Cheese model, it is irrelevant how many system defences an organisation is willing to impart; it is a statistical certainty that simultaneous failure will occur.

Minimising pressurised failure

So how do we reduce the probability of failure, in this case an event that compromises aviation safety? Well, the most obvious first step is to impart more system defences, such as greater supervision. Unfortunately, as an organisation increases its system defences, the cost and time required to employ them also increases. The number and type of defences is therefore purely dependent on circumstances, which must be risk-managed appropriately: likelihood versus consequences. In aviation, particularly military aviation, the consequences in the majority of cases can be extremely grave. Hence a large number of complex system defences are generally employed.

Why do system defences fail? They fail for a great number of predictable (e.g. human error) and unpredictable (e.g. weather) reasons. The most important aspect is to not unnecessarily contribute to the likelihood of failure, e.g. by fostering perceived pressure. Such pressure, especially in an already highly stressed environment, is an unwanted 'contribution' and a mechanism that encourages failure.

A number of 2004 ADF ASORs have identified perceived pressure to be a significant contributing factor in affecting maintenance system defences. The following outline a few:

- Due care: well trained technicians rushing and not completing tasks as specified.
- Supervision: supervisors becoming too task focused and hence losing situational awareness (i.e. supervisory defensive barriers not effective).
- Procedures: modified, skipped or not followed correctly.

Experience works both ways: an inexperienced technician pushing on, regardless of a lack of training and confidence to perform the task; an experienced technician rushing a job, or failing to refer to maintenance procedure documents — 'has done this job a thousand times before'.

Of course perceived pressure is not the only reason organisational defences fail, nor is it typically the sole reason an ASOR is raised in the ADF. The point is it is a significant contributor on the flight line, an unnecessary factor in an already stressed workplace.

Managing perceived pressure

How do we combat the problem of perceived pressure in military aircraft maintenance? A question most maintenance managers will have debated at some point, which is interesting because the responsibility principally rests with these maintenance managers. They are the lynch pin: they need to ***act as a filter to ensure pressure is applied proportionally and only when required***. The organisation as a whole can also contribute by providing its employees with effective tools, e.g. education and awareness training for the detection and processing of perceived pressure within the workplace.

Excessive pressure and stress on the flight line *will* elevate the inherent risk in military aviation safety. Let's ensure the pressure that is applied is absolutely necessary.

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Photo: Corporal Karen Livingstone

Photo: Sergeant Dennis Power

GETTING THE MESSAGE OUT

By Major (Ret'd) Jim Burger

This all began long ago when I was a training officer on *Hercules* doing a mission into Igloolic in the arctic. The airfield had no IFR approach and the weather was clouds scattered at 2500 feet, 4500 feet broken, and 4-5 miles visibility in light snow. We transitioned to VFR, went overhead to check the runway, and proceeded on a wide left hand downwind. I was in the right seat and the acting aircraft commander (AC) was in the left. He went so wide on downwind that he lost sight of the runway. I had reviewed the map, picked out some local features and gave him vectors to base leg and then to final. On downwind, I noticed his flying was a little erratic and he only maintained 500-700 feet above ground level (AGL). On base he dropped down to 350 feet. When we turned final we were at 250 feet AGL, still 5-7 miles back. I was noticing detail in the snow below and thought to myself this was just like a low level tactical route. At 150 feet AGL, 75 feet on the baro, the training engineer (not in the seat) called, "**Pull-up**!" The left seat was shocked and unaware of how low he was, so I took control, normalized the remainder of the approach, and asked him if he felt OK to land. He had been affected by the white out conditions; but after I took control, he adjusted and landed well. I realized I had not been aware he was in difficulty and had accepted our low altitude, not intervening soon enough. The rest of the crew was blissfully unaware.

We proceeded with an engine running off load, completed our checks and were set to take-off. The engineer in the seat had been so rattled that when I checked the overhead panel before rolling, I found he had left all of the boost pumps off in his check list. I calmed everyone down, had the checklist repeated, and we took off. The debrief was long, and when I returned to the squadron, we had a training day devoted to approach awareness. But this didn't go outside the squadron: the broader system did not get the benefit from the lesson we had just learned.

Not too much later, in 1991, we paid a horrible price when another crew on a different squadron did a VFR arctic approach and crashed. Changes were then implemented Forces wide…if I only knew then what I know now! ◆

Major (Ret'd) Jim Burger last served as an investigator at the Directorate of Flight Safety in Ottawa.

History of the FLIGHT SAFETY CREST

The distinctive diamond shape of the flight safety crest is not near as old as the flight safety program itself. In our database we have accident records dating back to the crash of an Anson from 124 Ferry Squadron in Macleod, Alberta, dated 17 January 1946. The first evidence of the crest was on the cover of *Hot Line* magazine, Fourth Quarter 1970.

Hey, That Thing's a Keeper!

This was followed up with an official introduction of the crest in the First Quarter 1971 issue of *Hot Line*.

In case you can't read the text here it is:

Designed to symbolize the two functions of FLIGHT SAFETY:

1. aircraft accident prevention — white; and
2. accident investigation — black;

and how these two functions interrelate and overlap to support and facilitate our primary objective:

SUCCESSFUL MISSION ACCOMPLISHMENT.

Diamond Fever

Shortly thereafter the first known adaptation of the crest to represent flight staff professionals appeared (*Hot Line*, Fourth Quarter 1971). Though the crest is not an exact replica of today's flight safety crest the motive and intent of the person wearing the crest is exactly the same — flight safety personnel are there to help!

Getting the Message Out

For a period, the Air Force was producing **two** flight safety magazines simultaneously. They were *Flight Comment* (1949 to present) and *Hot Line* (1963? to 1979).

Flight Comment, originally named *Crash Comment*, was more or less the publication of the Accident Investigation Branch — the precursor to today's Directorate of Flight Safety. On the other hand, *Hot Line* was the publication of Training Command.

The Passing (but slow gripping) of the Torch

As previously described, the current flight safety crest was the concept and property of Training Command Headquarters (and specifically of the Senior Staff Officer Flight Safety) until being eased into *Flight Comment*, Issue One 1979, when a small photograph appeared in an article titled "Guide to Investigation".

With the death of *Hot Line*, *Flight Comment* raided the shop and took what it wanted. In *Flight Comment*, Issue Three 1979, the editor explained the creation of the For Professionalism (FP) award alongside the Good Show (GS) Award. It was devised to preserve the Good Show's high standing as the "gold" standard of flight safety awards. Hence the FP was introduced to recognise meritorious acts of the "silver" standard. In the very next issue, Issue Four 1979, the first For Professionalism awards appeared with the now infamous black and white crest.

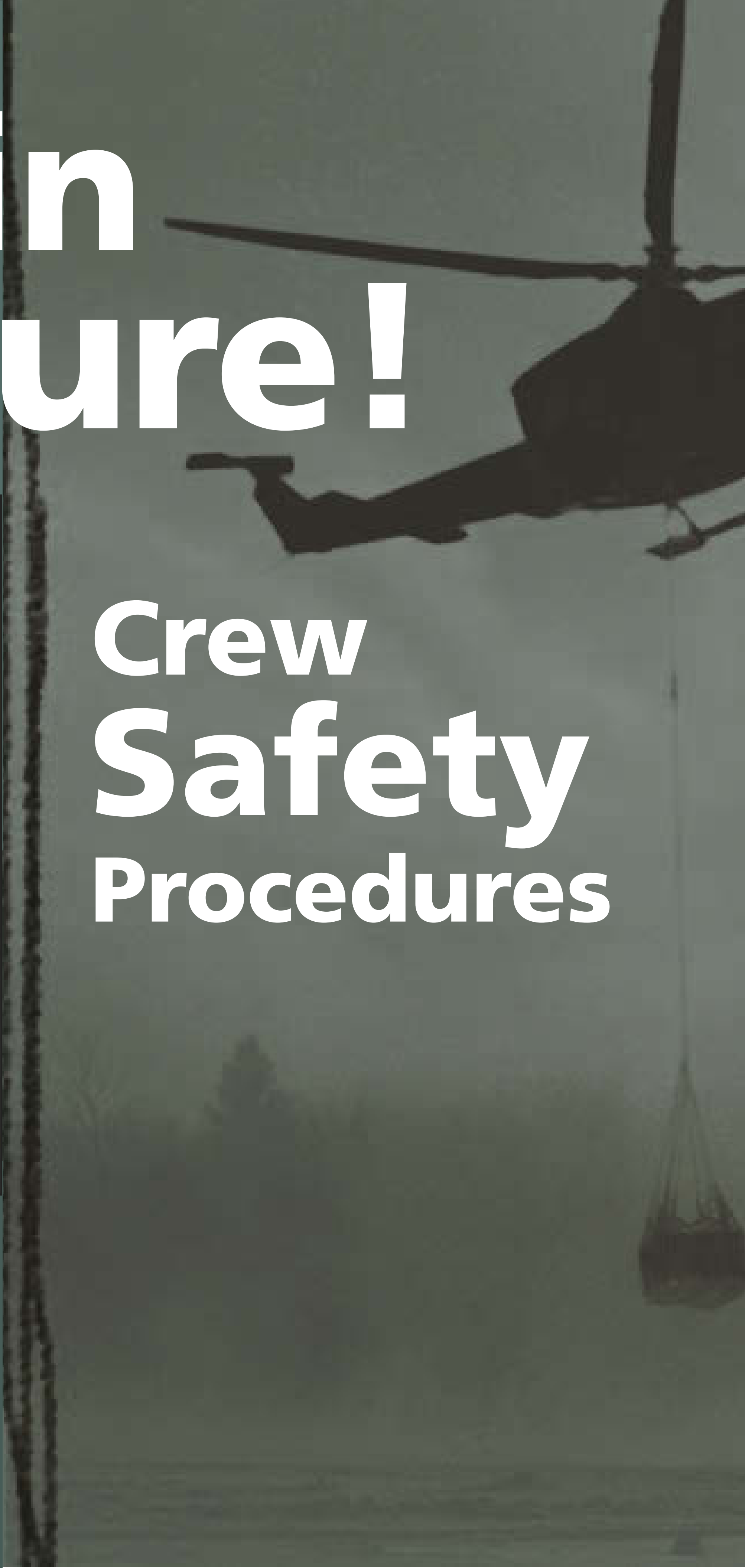
A Firmer Grip — NDHQ Recognizes a Good Thing

This continued for several years until finally, in *Flight Comment*, Issue One 1983, the "From the Director" article written by Colonel A.B.H. Bosman had the flight safety crest prominently displayed across from his photo.

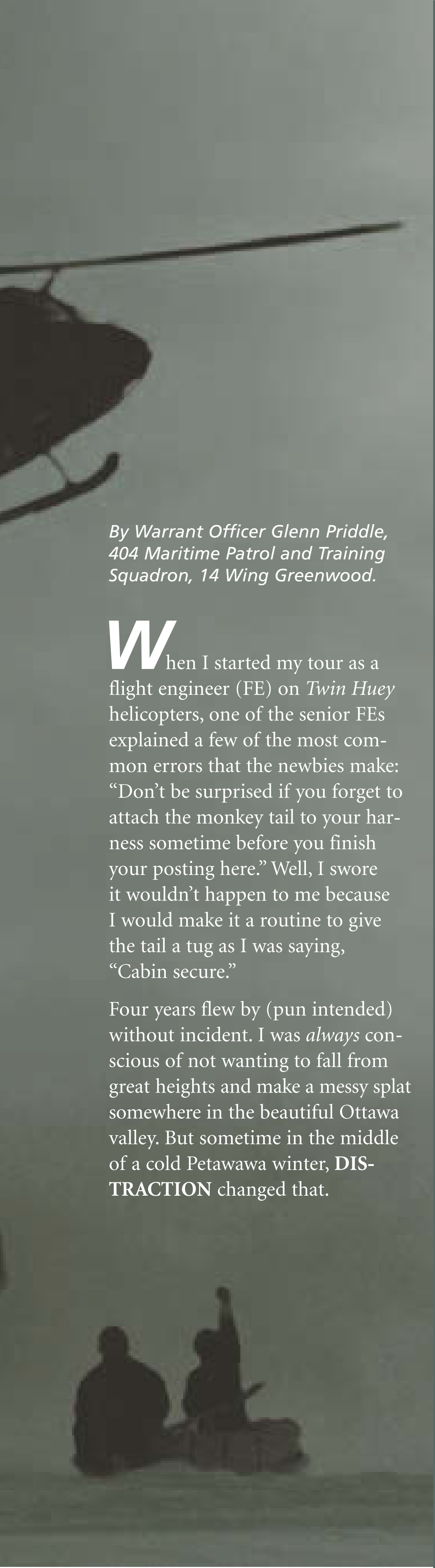
This short history of the flight safety crest is based on an in-house investigation of current holdings. If anyone has better/more substantiated info please let the editor of *Flight Comment* know at burt.rm@forces.gc.ca ◆

Cabin Secure!

Photo: Sergeant Gerry Antle



Crew Safety Procedures



By Warrant Officer Glenn Priddle, 404 Maritime Patrol and Training Squadron, 14 Wing Greenwood.

When I started my tour as a flight engineer (FE) on *Twin Huey* helicopters, one of the senior FEs explained a few of the most common errors that the newbies make: "Don't be surprised if you forget to attach the monkey tail to your harness sometime before you finish your posting here." Well, I swore it wouldn't happen to me because I would make it a routine to give the tail a tug as I was saying, "Cabin secure."

Four years flew by (pun intended) without incident. I was *always* conscious of not wanting to fall from great heights and make a messy splat somewhere in the beautiful Ottawa valley. But sometime in the middle of a cold Petawawa winter, **DISTRACTION** changed that.

We had set out on a routine night vision goggles, tactical navigation standard manoeuvres and emergencies (SME). It was bitterly cold that night (-25°C plus rotor wash). Everyone was bundled up with bunny pants and winter flying jackets plus our emergency survival vests. On top of all this the FE wears a safety harness to which he attaches a monkey tail to secure him to the interior of the helicopter. Now, just in case we are not already uncomfortable enough, we then attach a three pound lead weight to the back of our crew helmet to counter balance the night vision goggles (NVGs).

So off we went out into the cold, black Ontario night. The tactical navigation portion went off without a hitch. We returned to the local area to do some confined area operations and practice a few run-on landings. We were just about to call it a night when one of the pilots said he needed to do a NVG slung load. We didn't have a lot of fuel remaining. However, after a quick fuel calculation, we all agreed it could be done if we didn't waste any time.

The helicopter hover-taxied over to the slung load area and we parked in front of the 1,350 pound barrel of cement. I unfastened my monkey tail, exited the aircraft, and proceeded to crawl under the belly of the aircraft to hook the barrel to the cargo hook. The bundle of gear I was wearing with the NVGs attached made it quite cumbersome. After tunnelling through the snow and finally getting the load secured, I crawled back inside the helicopter and tried to catch my breath. The pilot asked for the new all up weight and torque required to lift the load. I fumbled in my helmet bag for my charts and quickly worked out the required info. As soon as I gave him the numbers I heard the engines winding up. I quickly cleaned up inside the helicopter and got myself into position in the open cargo door of the *Twin Huey*. I made all the appropriate calls to position the helicopter above the load and we lifted off for a quick circuit back to the slung load area. Nothing fancy, one circuit and put the load back on the ground. I was lying on my stomach, hanging halfway out of the helicopter monitoring the barrel that was now 450 feet off the ground. My fingers were numb and tears were freezing to my face, but I knew all I had to do was get this thing on the ground and head home to a warm house. Anyway, we set the load back on the ground and positioned the helicopter behind the barrel so I could jump out and put the slinging gear back in place on top of the barrel.

I reached around to unfasten my monkey tail from my harness but… it wasn't there. I did another swipe at it in disbelief! I had just flown a circuit at 500 feet above frozen earth, hanging halfway out of a helicopter, secured only by the weight of my lower body and my numb fingers. I was shocked, I was afraid and spent some time shaking my head… I couldn't believe I was that stupid, I couldn't believe I was that close to **SPLAT**! Plain and simple, I was distracted because I was rushing and uncomfortable, and rather then saying time out, I continued on with a sequence that could have ending up with tragic results. ◆

That night

Photo: Sergeant Ron Hartlen

By Captain Steve Cote, 2 Canadian Forces Flying Training School, 15 Wing Moose Jaw

That night, the squadron was participating in a joint exercise with an army infantry unit. I was taking part as a co-pilot and flying with an experienced aircraft commander and flight engineer. The task of the four CH146 *Griffon* helicopters involved consisted of moving troops from the pick-up zone (PZ) to the landing zone (LZ). Everything took place in training areas that were well known to crewmembers.

The mission was carried out using night vision goggles (NVG) in adverse environmental conditions. There had been heavy snowfall in the area over the past 24 hours. With night approaching and the temperature dropping, the precipitation stopped, but the snow on the ground was now deep and light—ideal conditions for the rotor wash to create a snowball around the helicopter during take-off and landing. This snowball could obstruct the crew's vision very quickly and without warning.

The aircraft commander discussed the snowball effect with the crew prior to take-off and reminded them of the procedures to follow. We didn't anticipate problems at the PZ, as there were several reference points near the helicopter to guide the crew during descent. However, the same could not be said for the LZ. The first part went off as planned. The troops boarded and the four aircraft headed for their destination. The LZ is located right in the middle of a white field with a few aeration pipes emerging from the ground as the only visual reference points for landing.

The helicopter stabilized and hovered at 50 feet above ground, just above the snowball, and began its vertical descent. I was at the controls and the aircraft commander followed my movements on the controls as required in the procedures. At approximately 10 feet above ground, I lost all outside visual reference, except for one (the pipe) and began to dangerously tilt the aircraft to the left without knowing it. At the same time, the commander stated that there no longer was outside visual reference. The flight engineer mentioned a drift to the left. The commander advised me that he was taking the controls and performed a vertical climb using the instruments. I assisted so as to avoid exceeding the aircraft's normal parameters, and we dropped off the troops in an alternate LZ.

The mission ended successfully because of the outstanding cooperation of the crew and effective procedures that specifically described the role of each crewmember. We all learned a lesson that day, which came in handy when I became an aircraft commander a few years later. Unfortunately, no flight safety alert was drafted; nobody, other than us, was able to benefit from this flight, which ended successfully, to strengthen knowledge and possibly avoid a future, more dramatic incident. ◆

Photo: Sergeant Ron Hartlen

COMING SOON TO YOUR LIBRARY

New Edition of Flight Safety Policy Document

By Jacques Michaud, Director of DFS 3 (Promotion and Services), Ottawa

The flight safety (FS) reference document *Flight Safety for the Canadian Forces* (A-GA-135-001/AA-001) has been updated and released by the Chief of the Chief of Defence Staff. The last edition of this document was published in December 2002, but it proved to be an unpractical document being divided into three separate sections: Standards, Regulations and Procedures. Information was repeated in different sections and sometimes contradicted itself. Finding the complete information related to a specific topic forced the user to search the individual sections. Furthermore, the 2002 edition was never amended to correct errors or to reflect current policy and procedures. Without a doubt, the A-GA-135-001/AA-001 (hereafter called the 135) needed a good facelift and thorough revision to ensure its pertinence and usefulness across DND/CF organizations conducting or supporting flying.

In the course of rewriting the 135, major consultation was done over the last year with FS personnel integral to units and contractors, 1 Canadian Air Division, the Director General of Aerospace Equipment Program Management (DGAEPM), and Cadet staff. A Writing Board was conducted in February 2006 when approximately 20 FS personnel gathered in Ottawa to completely review the 135 and suggest amendments to the Director of Flight Safety (DFS). Once amended, several versions were circulated electronically, after which more changes were incorporated.

The most important changes to the previous version include the adjustment to the definitions of "Major Aircraft Component", "Aircraft Damage" and "Personnel Injuries", and the introduction of an investigation classification system. This allowed DFS to determine who will investigate an occurrence and to what level. The re-publishing of the 135 was an opportunity to align, when applicable, our policies and procedures with the International Civil Aviation Organization (ICAO) and the Transportation Safety Board's best-practices, procedures, and upcoming *Aeronautics Act* legislation.

Since the introduction of uninhabited aerial vehicles (UAVs) in the Canadian Forces, DFS did not have a systematic approach for determining the level of investigation required for a specific occurrence. By experience, the process was well suited for manned aircraft, but this was not the case for UAVs. Contrary to manned aircraft, some UAVs are designed to perform a crash recovery when mechanical difficulties are encountered. Would DFS order a full-fledged FS investigation involving up to 15 investigators and specialists for any accident involving total or near loss of an UAV?

The first significant change was to how DFS categorizes accidents and incidents. The new occurrence categorization system is very simple and intuitive. It will eliminate the confusion of having so-called "E" Category accidents when, by the old definitions, Cat "D" and "E" were considered incidents. Up to now, an aircraft occurrence involving no damage to the aircraft but where personnel have suffered serious injuries was categorized as a Cat "E" Accident. This approach was somewhat difficult to rationalize: it skewed the statistics and put the value of aircraft damage ahead of the importance of personnel injuries.

As shown in *Table 1*, an FS occurrence will now be assigned an alphabetical category of "A" thru "E" based on the higher of either the Aircraft Damage Level (ADL) or Personnel Casualty Level (PCL). Therefore, all occurrences having either serious damage, casualties, or both will be considered accidents, and other occurrences will be considered incidents. The old term "Category of Damage" was changed to "Aircraft Damage Level", with the alphabetical system ("A" thru "E") being replaced by a verbal qualifier. The definitions of ADL were adjusted to focus the ADL assigned according to the damage suffered by an aircraft and the level of maintenance required to fix it, as opposed to the capacity to move the aircraft and which maintenance organization would fix it. The "Personnel Injury" term has been replaced with "Personnel Casualty Level" to reflect the current CF Medical taxonomy in CFAO 24-1 for describing personnel casualties. The redefinition of ADL, PCL and Occurrence Category will also facilitate the mapping of CF occurrence data to ICAO data and enhance international data sharing.

A second significant addition to FS procedures is the introduction of a rational investigation decision tool matrix. This matrix, shown as *Table 2*, serves as a decision tool to determine the level or Class of investigation needed for an occurrence, and which organizations are liable to investigate. The Class of investigation is based not only on the Occurrence Category, but also

AIRCRAFT DAMAGE LEVEL	PERSONNEL CASUALTY LEVEL	OCCURRENCE CATEGORY
Destroyed or missing	Fatal injury or missing	A
Very serious damage	Very serious injury / illness	B
Serious damage	Serious injury / illness	C
Minor damage	Minor injury / illness	D
Nil	Nil	E

Table 1 — Occurrence Category Matrix

on the degree of compromise to safety of flight during the occurrence and other aggravating factors that may elevate the level at which an occurrence should be investigated. Safety of Flight Compromise plays a role when, for example, DFS elects to investigate an "E" occurrence where nobody was injured and the aircraft was intact, but where the crew or other personnel were unduly put at risk.

While the matrix may indicate that a unit or Wing could carry out the investigation, DFS may decide to elevate the Class of investigation or appoint a different investigation agency. The latter may be necessary if it might lead to a more effective reduction of risk to persons, property or the environment, and to maintain the trust of CF personnel and the general public in the FS Program and the CF. Therefore, the matrix serves as a guide, but DFS retains the authority to determine the Class of investigation, the unit conducting the investigation, and the type of report to be submitted.

Another change that has been introduced is the provision of guidance for repetitive occurrences where only a limited benefit may be gained by carrying out a detailed investigation. In the past, these occurrences were labelled in the Flight Safety Occurrence Management System (FSOMS) as "For Tracking Purposes Only" (FTPO). The criteria used to qualify an occurrence as FTPO were inconsistent, and FS personnel were entering occurrence details in FSOMS inconsistently. The term "FTPO" was misleading as it gave the impression that no investigation had been carried out and that the data was only valuable for trend analysis. These occurrences are now referred to as Repetitive Occurrences (ROs), where this is defined as a recurring type of incident where the event and investigation results are consistent with a previous investigation. This simple methodology requires minimal effort and allows the capture of these occurrences as they still provide valuable statistical data. It must be understood that the use of RO procedures and terminology is limited to Class III or IV investigations being reported in the form of a Supplementary Report or a Complementary Report.

In conclusion, the new 135 was amended to make certain that the FS Program is able to support expanded, operationally focused DND/CF flying activities while remaining safe. The scope of the FS Program was written into the 135 to ensure that individuals belonging to any organization, conducting or supporting air operations, will have in place a safety framework within which to work. The Chief of Defence Staff is the releasing authority and he directs that every unit conducting or supporting air operations *shall* have a flight safety program.

The new A-GA-135-001 is available on the DFS Internet (http://www.airforce.forces.gc.ca/dfs/pdf/AGA135_dec02_e.pdf) and Intranet (http://airforce.mil.ca/dfs/pdf/subjects/AGA135_Dec02_e.pdf) sites in PDF format. A limited number of paper copies will be distributed to key stakeholders. An annual review of the document will be done to ensure it is kept up to date, with amendments published as required. While great care has been taken to produce a quality document, errors or omissions may still be present. Please inform DFS 3 of any such items at dfs.dsv@forces.gc.ca, attention Director DFS 3. ◆

FACTORS			INVESTIGATION		
OCCURENCE CATEGORY	SAFETY OF FLIGHT COMPROMISE	FUTURE IMPACT ON CF	CLASS	AGENCY	REPORT TYPE
A	—	—	I	DFS	Flight Safety Investigation Report
B, C	Extreme to High	Extreme to High	II	DFS	FSIR or Abbreviated FSIR or Enhanced Supplementary Report (ESR)
C, D	Medium to Low	Medium to Low	III	Wing or Unit	ESR or Supplementary Report (SR)
D, E	Low to Nil	Low to Nil	IV	Unit	SR or Complementary Report

Table 2 — Investigation Class Matrix

ICING

Aircraft Ground Icing Operations in "FROST"

By Mr. Ken Walper, Directorate of Technical Airworthiness, Ottawa

Background

Frost is nothing new for most Canadians. In fact, it would be difficult to imagine a born-and-raised Canadian that had never encountered frost. But what is frost? How does it form? What effect does it have on aircraft? How can it be prevented from forming on aircraft? And how can I remove it from my aircraft? This article will address each of these points in turn.

Frost Effects on Aerodynamics

Frost is a nasty contaminant. However in daylight, frost can be deceiving and can appear "jewel-like". Don't be fooled by the innocuous appearance of frost; it can be lethal.

Frost is very rough aerodynamically, and the height and close spacing of the frost crystals over the wing surfaces can be such that it disturbs the airflow much more severely than other forms of frozen contamination. The aerodynamic effect of frost on lift is most pronounced for frost located on or near the wing's leading edge. The lift-loss effect is the most severe for aircraft without leading edge devices. Frost's impact on drag is particularly severe if it is distributed widely on the aircraft. In this case, it seriously affects an aircraft's ability to achieve a predicted climb gradient. The effect of frost on an aircraft's performance and handling qualities can prove to be lethal irrespective of the size of the aircraft involved.

Decreases in the coefficient of lift can reach 30% with an attendant drag rise of as much as 40% on a modern aerofoil section. Frost airflow disturbance can also cause aircraft control difficulties, especially if the frost is present asymmetrically from wing to wing, such as might be the case if one wing was in the early morning sunlight and the other wing was in the shade.

The effect of frost on an aircraft's performance and handling qualities can be catastrophic.

Frost must be considered "the enemy".

Definition of Frost

Transport Canada defines frost as "a thin white deposit of frozen precipitation, which is of fine crystalline texture, that adheres to exposed surfaces usually during below freezing, calm winds, cloudless nights with air of high relative humidity and with no precipitation falling. Often the frost deposit is thin enough for surface features underneath, such as paint lines, to be distinguishable." The Society of Automotive Engineers (SAE) sub-committee AC-9C defines frost as "ice crystals formed on a surface by water vapour deposition from the atmosphere."

How Frost Forms

Frost forms by deposition of water vapour onto a surface directly from vapour to solid without passing through the liquid stage. The deposition will occur when the surface's temperature is below the frost point of the air above it. The surface can be cooled to below the frost point by several ways: one way is by cold soaking the wing, and another way is by radiation cooling.

The formation of frost does not require 100% relative humidity; in fact, Transport Canada tests suggest that the most rapid frost formation occurs near 75% relative humidity. Furthermore, Transport Canada sponsored testing has revealed that the upper surface of a wing can be as much as 8°C colder than the ambient air temperature due to radiant cooling at night. Operational crews need to be aware that these conditions are conducive to the formation of frost. The lower the outside air temperature (OAT), the more tenaciously the frost appears to adhere to the surfaces.

Frost can also form on the upper and lower surfaces of wings that have their fuel tanks filled with below freezing temperature fuel. The below freezing fuel "cold soaks" the wing and brings the wing's surfaces down to below the frost point temperature. The moisture in the air then freezes on contact with

Photo: Master Corporal Ted Durdin

the wing, forming frost. This mechanism for the formation of frost can often be the most surprising for operational crews.

Frost Occurrence

Frost occurs very frequently in Canada during the winter icing season. In some regions of Canada, such as the far North, frost can be a dominant form of aircraft contamination during winter operations. Two of Canada's busiest airports, Toronto Pearson and Montreal Trudeau, report that "frost only" conditions constitute 30% of their deicing activity. This value may be much higher in the Canadian North.

Frost Detection

Aircrew need to learn to identify when conditions conducive to frost formation exist and be particularly vigilant during pre-flight inspections. Frost is easily detected visually in good lighting conditions but is more difficult to detect if lighting is poor such as when low contrast lighting conditions exist or at night. While the frost roughness isn't always immediately evident, it is often the frost sparkle noticed on the walk around that tips off the flight crew to the presence of frost. A tactile inspection with the un-gloved hand will immediately reveal the roughness aspect of the frost deposited on the aircraft surfaces.

Avoiding Frost

Generally it is not possible to alter nature by dismissing the conditions conducive to frost formation, but it is possible to take steps in preventing the formation of frost.

Perhaps the single most effective method for preventing the formation of frost is by leaving the aircraft in a heated hangar. Placing an aircraft in a hangar to prevent frost formation is very often not possible and is dependent upon such issues as the operational location, the size of the aircraft, the costs, the utility of the airfield, and operational considerations. Some smaller aircraft, such as the *Twin Otter*, may have wing and tail "sleeves" placed over the wings and tail for overnight frost protection when the aircraft is left outside. At some major Canadian airports, anti-icing fluid is placed on the wing upper surfaces to prevent the formation of frost overnight when the large commercial transport aircraft are left outside on the ramp overnight.

Removing Frost

Frost must be removed from the aircraft's critical surfaces prior to flight. Transport Canada defines the critical surfaces as the wings, control surfaces, rotors, propellers, upper surface of the fuselage on aircraft that have rear-mounted engines, horizontal stabilizers, vertical stabilizers, or other stabilizing surfaces of an aircraft.

There are a number of ways in which frost can be removed from an aircraft; a few will be discussed here.

Various mechanical frost removal methods have been used over the years with varied success rates. Providing that the aircraft surfaces, angle of attack vanes, pitot-static heads, and other vulnerable components aren't damaged, it may be possible to completely remove frost using a broom, a special scraper, a rope used in a see-saw fashion, or other means.

Mother nature can be of great assistance in removing frost if time is not of the essence. If the day following a frosty night is a sunny one, then the aircraft may be left in the warming sun, away from any shadows, and the sun will cause the upper surface frost to sublimate off the aircraft.

Heated air can also be used to remove frost. A traditional "Herman-Nelson" or other such air heater may be used to blow heated air over the frosted surface; depending upon the aircraft, special devices may be required to accomplish this task successfully and in a timely manner. The use of hot air to remove frost can be a very tediously slow process during conditions of very cold temperatures or when there is some wind. Recently, infrared devices, both portable and those installed in an open ended "tent hangar", have been developed and promise to be a very effective, rapid, efficient and environmentally friendly way in which to remove frost or other frozen contaminants from an aircraft.

Currently, the most rapid and most popular method for removing frozen contaminants from an aircraft's critical surfaces is the use of heated aircraft deicing fluids (ADFs). SAE Type I fluid is designed specifically for removing frozen contaminants from aircraft. It is designed to be used when heated to an approximate 80°C nozzle temperature. If the protection time provided by the SAE Type I fluid is not long enough, a layer of SAE aircraft anti-icing fluid (AAF) may be applied after the SAE Type I fluid has been used to remove the frost, where approved for the aircraft type. A typical holdover time (HOT) value for Type I fluid, in frost, at –10°C, is 45 minutes. A typical HOT value for Type IV fluid, in frost, at –10°C, is 12 hours.

Using De/Anti-Icing Fluids to Remove Frost

The use of fluids requires proper training and proper equipment. It is important to use only those fluids that have been approved for use on your particular aircraft. The fluid's lowest operational use temperature (LOUT) must be respected. The fluid must

Twin Otter Type I Fluid LOUT Issue, Resolute

By Ken Walper, DTA 5-6C2

Background

The following incident was taken from a report by a Crew Chief on 440 (T) Squadron. The report was an e-mail dated Thursday, 18 August 2005. The deicing fluid used in this instance was Kilfrost DF 88 Plus; the fluid's dilution was not stated.

Report

The *Twin Otter* aircraft was parked overnight on 21 March in Resolute Bay, Nunavut. Overnight the weather was clear skies, light winds and the temperature was –38°C. The following morning, the aircraft was coated in a moderate layer of hoar frost with a temperature of approximately –36°C. A deicer fluid applicator with a heater attachment was placed inside a heated building and allowed to warm-up for 1 hour. The applicator was carried outside, the fluid temperature was not measured but was hot to the touch and steam could be witnessed rising from the open fluid bottle. Fluid was immediately applied to the outer tip of the LH wing. Approximately ¾ of a liter of fluid was applied to a 3 foot by 3 foot area of the wing. Fluid had a limited effect in melting the frost and seemed to combine with the frost in a gelatinous slush. The resulting slush had the consistency of Vaseline and was clearly not in a state in which it would flow off the aircraft during a take-off roll. In fact, the resulting slush had to be wiped from the wing (with some difficulty) with absorbent material.

In my opinion the temperature of the wing and surrounding air immediately cooled the deice fluid causing it to become viscous and ineffective in melting the existing frost. It is possible that with sufficient quantity of fluid being applied the wing would have been heated to such a temperature as to allow the fluid to remain liquid and flow off the wing. However, given the limited quantity of fluid in the applicator bottle (11 litres) there was likely insufficient thermal energy in the fluid to warm the wing surface sufficiently to prevent the fluid from jelling.

This product and applicator may be effective in warmer temperatures or when used on localized ice accretion area (like on the leading edge of the wing). However, under the conditions experienced above, this product was ineffective for deicing.

End of excerpt.

Comment

Based upon the available evidence, it appears that the fluid was used below its LOUT. There is also some question about the adequacy of the temperature of the applied fluid and the quantity used.

NOT be used at an OAT below the LOUT or the fluid may cause catastrophic aerodynamic deterioration on the wing and control surfaces.

When deicing fluid is used for frost removal, there are some very basic requirements in its use. The main ones include

- use of the correct SAE fluid and dilution;
- respect for the fluid's LOUT;
- the use of sufficient quantities of the approved fluid;
- the proper heating of the fluid;
- the proper application of the fluid;
- proper training for those involved in the fluid application; and
- the use of the proper equipment.

Experience has shown that if any of these requirements are not met, there exists the potential for extremely dire consequences. Refer to the sidebar on page 27 for a recent example of the consequences of not respecting the fluid's LOUT limitations. It is worth noting that not all SAE Type I fluids have the same LOUT: some fluids are better suited to low temperature extremes than others.

The effect of frost on aircraft performance and handling qualities can be catastrophic.

Familiarity with the presence of frost during Canadian winters can unwittingly lead to complacency. Be on the alert for the signs that frost may be present, and treat frost with the respect that it deserves by dealing with it.

Frost must be considered "the enemy".

Questions concerning aircraft ground icing operations in general can be directed to Mr. Ken Walper, DTA 5-6C2 at (613) 991 9530 or Walper.KL@forces.gc.ca ◆

Challenger 604 in Birmingham, England

By Ken Walper, DTA 5-6C2

Scenario

On the morning of January 4, 2002, a ***Challenger*** 604 crashed on takeoff at Birmingham International Airport in the UK. The airplane had sat on the freezing tarmac overnight, accumulating a layer of hoar frost on the wings estimated at some 1-2 mm thick.

Crew communication

According to the UK's Air Accidents Investigation Branch (AAIB) report, the captain asked the copilot, who was the flying pilot, about the situation.

Commander: *"Got a (unclear) frost on the leading edge, on there, did you look at it?"*

Handling pilot: *"Huh?"*

Commander: *"D'you (unclear) that frost on the leading edge / wings?"*

Handling Pilot: *"Did I feel 'em?"*

Commander: *"Yeah, did you-all check that out?"*

Handling pilot: *"Yuh."*

Investigation comments

The AAIB concluded that the crew's discussion of the icing situation was "ineffective".

"The discussion on icing initiated by the captain did not adequately address the issue or arrive at an appropriate conclusion," the AAIB said.

During taxi to the runway, the crew carried out the pre-takeoff checklist. As the AAIB report recounted, when the anti-ice checklist item was reached, the handling pilot remarked, "We may need it right after takeoff."

The AAIB report said, "This response seems to embody only a token acknowledgement of the de-icing problem—as something that could be left until later."

The airplane was not de-iced before taxiing to the runway for takeoff. As the AAIB noted, all other aircraft that had been parked overnight at Birmingham, and scheduled for morning flights, were de-iced. They departed safely. Immediately after getting airborne, the accident aircraft rolled sharply to the left and struck the ground inverted. Total flight duration was approximately 6 seconds. The AAIB speculated that the airplane had been parked in such a way that one wing was in the early morning sun and the other in shadow, leading to asymmetric clearing of the frost and stall of one wing. On impact, fuel tanks ruptured and the aircraft slid to a halt on fire. All five aboard were killed.

WHITEOUT

By Brad Vardy, Editor of Aviation Safety Vortex

Back in the old days, a Canso was on a very long IFR ferry trip in the Arctic Islands. For the crew it was a monotonous routine — monitoring the instruments and listening to the roar of the two big radial engines just above their heads. There was nothing to see out of the windows, just a white, featureless blank.

It was a boring and undemanding afternoon, until the captain looked out through the windscreen and saw his flight engineer standing in front of the aircraft with a big grin on his face. This came as quite a surprise to the captain, **whose training and background had not prepared him for coming face-to-face with anyone while in cruising flight, let alone a member of his crew.**

The Canso had flown into very gentle rising snow-covered and featureless terrain. The impact had been so soft and gentle that amidst the rattling, roaring and vibrating that constitutes cruising flight in this type of aircraft, the crew hadn't noticed the deceleration at all. The flight engineer had happened to look out of one of the Perspex blisters in the tail of the aircraft and discovered that he could see the ground, quite motionless just a few feet below him. So he got the aluminium ladder out, climbed down to the ground and walked round to the front to get the pilot's attention.

Maybe it's urban legend; maybe it's a true story — who knows? I suppose, considering the boat-shape of the Canso hull, that it could happen, but one thing's for sure — it's not likely to happen in a helicopter. I do know one chap who claims to have hit the ice at cruise speed in a Bell 206 on fixed floats, and suffered nothing but a gentle bounce, but the more likely scenario involves a catastrophic break-up and debris field.

If you are a VFR commercial pilot flying in Canada, sooner or later you are going to experience loss of visual reference to some extent. If you're lucky, it will be for only a second or two before your frantic eyes find a clump of trees or something else that tells you which way is up. If you're not lucky, you'll likely join the ranks of those who have found out the hard way that the "seat of your pants" is easily fooled. For those who haven't experienced it, it can happen something like this:

The weather is deteriorating. You know the situation is not good, but you press on, hoping it will improve. It doesn't — it gets worse, and you find yourself losing good reference. Your eyes are darting from side to side and your pulse increases. You slow the aircraft, still searching for visual clues. Your breathing speeds up, and your pulse is now racing.

You feel a cold rush flood through your body, and a strange sensation of your insides relaxing as adrenalin and fear overcome concentration and reasoned thought. Then comes the disbelief; the absolute unwillingness to accept that your body has let you down and you are helpless.

Let's look at some examples of descriptions taken from Canadian accident reports from the past few years:

- *During approach for landing on a glacier and at 8 000 ft above sea level (ASL), the pilot of a 205 entered a whiteout-like condition in swirling snow. He lost all visual reference and touched down hard, causing damage to the skid-gear.*
- *Nearing destination, an aircraft flew into whiteout conditions. All visual reference was lost before the pilot could complete a landing, and the helicopter rolled over on touchdown.*
- *An aircraft's main rotor hit the ground after the left skid dug into snow surface during a mountaintop landing. The aircraft was still in forward motion at touchdown due to wind shift and whiteout.*
- *A sling load proved heavier than the pilot expected, and he couldn't get airborne. He hovered with the load resting on snow-covered ice and lost visual reference in the blowing snow. The pilot released the sling load, while the helicopter was in a nose-high attitude. The tail rotor struck the snow surface and the machine rolled over.*

- *A pilot encountered whiteout conditions and attempted to turn back. The aircraft crashed on the Arctic sea ice during the turn.*
- *A pilot lost visual reference in whiteout over an ice-covered inlet and flew into the ice.*
- **A pilot aborted his third take-off attempt in blizzard conditions. On touch-down in whiteout conditions, the helicopter rolled on its side.**
- *A aircraft struck ice in nearly flat attitude in whiteout conditions…*

The following accident resulted in three serious injuries. One has to wonder about what was going through the pilot's mind when he asked the passenger to "keep an eye on the altitude."

- *A 206 pilot took off on a charter with two passengers for some survey work. The weather was marginal but there were no weather reporting stations in the area, so they decided to "have a look at it." When they turned out over the sea ice to look for some fuel barrels, the pilot soon found himself in whiteout. He asked a passenger to keep an eye on the altitude while he turned the 206 to regain visual reference with the shoreline. In the turn, he lost altitude and the helicopter struck the ice.*
- *The ceiling was low and the visibility was poor, in falling snow, but a 206 pilot spotted his party on the lake. Day-Glo cloth markers indicated their location. The ice was covered with four inches of fresh loose snow. As the helicopter entered a pre-landing hover, the rotor wash blew up the loose snow and the pilot became disoriented. The machine rolled and the main rotor blades struck the ice.*
- *A 206 was number two in a group of six helicopters en route from Charlottetown, P.E.I., to an ice flow in the Gulf of St. Lawrence to observe the seal-hunting operation. As the group approached the halfway point, they encountered whiteout conditions in light-to-moderate snow. The ice they were flying over was relatively flat and also featureless. The accident helicopter reduced speed to about 60 kt and descended in an attempt to maintain visual contact with the ice. As the helicopter neared the ice, number-three aircraft radioed a warning to pull up, but the warning came too late. The 206 hit the ice with sufficient force to tear the float gear off and crush the crew and passenger seats.*
- *A pilot landed in a mountain meadow to pick up skiers. As the helicopter did not come out of the whiteout as expected on takeoff, the pilot aborted. The right skid dug in and the machine rolled over.*

Sadly, there are many more examples; they happen every year. What may surprise you is that many of them happen in the summer months, when Mother Nature hasn't yet released her grip on winter in our northern regions. One study found that in the preceding nine years, 25 percent of the whiteout accidents took place during the summer operational season. This may indicate that currency plays a role in both the hands-on skills and decision making required to deal with winter weather.

The vast majority of low-speed take-off and landing accidents are preventable by good decision-making, with careful consideration given to

- the conditions of the area;
- the recent weather, wind, temperature (is the snow heavy, or light and fluffy?);
- patience; and
- technique (see "Snow Landing and Take-off Techniques" in *Vortex* Issue 1/2003).

In the en route phase of flight, many human factors gurus and experienced pilots theorize that the stage is set for the accident long before the whiteout condition exists. They believe that if you start the trip with the mindset that you'll return or divert if the weather deteriorates beyond a given point, you are more likely to do so when it does. Conversely, if you have nothing but the destination or an optimistic forecast in mind, you're more likely to press on. This is definitely something to consider when planning your next flight into the frozen Canadian winter.

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STICK WITH

Innovation in Deicing

By Mr. Kyle Jackson

There is a pointy wooden stick in my cubicle which, believe it or not, was standard equipment on all CH149 *Cormorant* Search and Rescue (SAR) helicopters during the winter of 2004-2005. Here is the story…

The *Cormorant* is among the few helicopters in the world equipped with an ice protection system. This system allows the *Cormorant* to fly in conditions where ice may form on the aircraft—generally through clouds or fog at temperatures below freezing. This system provides heat to the rotor blades and other vulnerable areas, preventing ice build-up. A helicopter without such a system would accumulate ice on vulnerable areas very rapidly, which can lead to loss-of-control, as has been demonstrated by many crashes around the world. Those unprotected helicopters are thus not certified for flight in icing conditions, and must divert around any cloud or fog banks in which icing is expected.

Since the *Cormorant*'s primary role is Search and Rescue, it is crucial that it can fly the most direct route possible to and from its mission area. Without an icing certification, the route is at the weather's mercy. But with an icing clearance, the *Cormorant* can fly right through most icing situations. It is currently the only Canadian Forces helicopter with this capability, though the new CH148 *Cyclone* will be similarly equipped.

Got ice?

Certifying the *Cormorant* for icing involved an extensive review of tests results and analyses from the manufacturer. Among the considerations is ice shedding from various parts of the aircraft that can damage other parts of the aircraft.

For example, ice shedding from the rescue hoist mounted on the side of the *Cormorant* can impact the tail rotor. (It's really the same situation you see on the highway every winter, when ice and hard snow leaps off the top of transport trailers, sometimes hitting the car following behind it.) If ice can hit a critical component, such as the tail rotor, then it must be shown that the component can safely withstand the worst-case ice strike expected. In flight tests in severe icing conditions, the *Cormorant* rescue hoist accreted a one-kilogram chunk of ice—a noteworthy hazard to the tail rotor!

The airworthiness review of tail rotor vulnerability was still progressing as the icing season of winter 2004-2005 arrived. Without a full icing clearance, the *Cormorant* was handicapped on missions where icing conditions prevailed (which is many of them!). Until the full icing clearance was available, an interim option was desired. Several ideas were bounced about between the Directorate of Technical Airworthiness (DTA), the Weapon System Manager (WSM), and the

H IT!

operators. All of the ideas were undesirable, but in the interest of the SAR mission, a "lesser-of-evils" solution was adopted: during flight in icing conditions, the crew would periodically open the sliding rescue door at the side of the aircraft, and a crew member would lean out (while securely anchored to the aircraft!) and use a stick to clear the ice from the rescue hoist. This would prevent the ice from building to a size large enough to damage the tail rotor.

Ice on rescue hoist fairing

DTA gave the basic requirements for this stick to the Standards squadron—that it had to be anchored to the aircraft so it couldn't be lost into the engine intake or a rotor and how often it had to be used in icing conditions—and the operators designed the stick and a procedure to use it. Despite the NHL strike offering a surplus of hockey sticks, the ultimate design looks simply like a piece of broom handle with a parachute chord at one end to anchor it. Plain, boring, but fully functional! These humble yet brave sticks were rushed into service aboard every *Cormorant* in order to allow the most unrestricted icing operations possible for the remainder of the winter.

Give it some stick!

The airworthiness review eventually determined that the tail rotor could safely withstand the worst-case ice strike; therefore, clearing ice from the rescue hoist in flight was not necessary. The ever-popular de-icing sticks were thus retired after a couple months of distinguished service. One of these sticks now serves proudly with the DTA 5 team, where it controls rowdy section meetings on airworthiness policy!

The point of this story (pun intended) is that an 'airworthy' solution need not equate to 'complicated', 'expensive' or 'slow'. Sometimes an interim 'quick-and-dirty' idea is good enough to get the mission done, until the desired solution is implemented. The stick in my cubicle is a great reminder of that. ◆

This article was printed with the permission of the Technical Air Worthiness Authority's Communiqué. *It originally appeared in the October – December 2005 edition.*

EPILOGUE

TYPE: *Griffon* CH146493
LOCATION: Goose Bay, Labrador
DATE: 29 March 2004

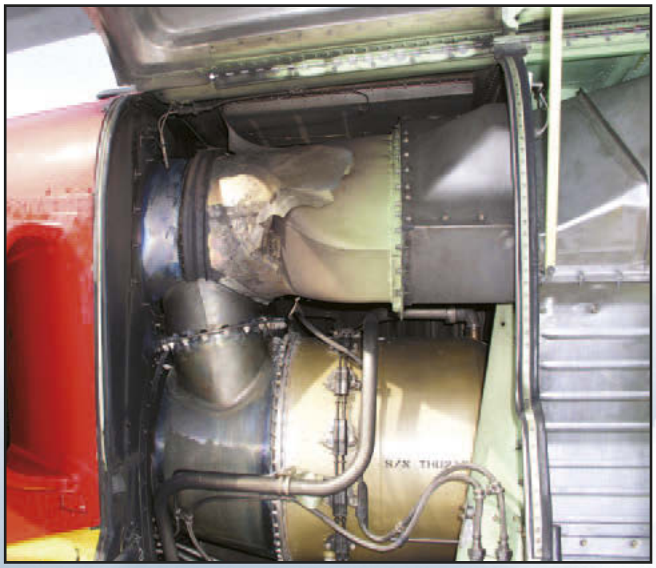
The crew was flying a scheduled emergency training mission to practice "high side governor failure". The co-pilot correctly initiated the emergency by raising the collective. The pilot lowered the collective to regain single engine parameters in anticipation of switching the governor switch to manual. After identifying the governor switch and hearing, "Confirmed," by the flight engineer, the pilot selected the governor switch to manual. Shortly thereafter, the 'ENG 2 OUT' and the 'FIRE 2 PULL' lights came on as the aircraft experienced a power loss of the number two engine. The pilot took control of the aircraft and the crew executed a number two engine fire emergency procedure, successfully landing on a snowmobile trail just outside the perimeter fence of the Base. Following shut down, extensive heat damage inside the number two engine compartment was noticed. Further investigation revealed extensive heat damage to the number two stage of the power turbine. The aircraft sustained "C" category damage.

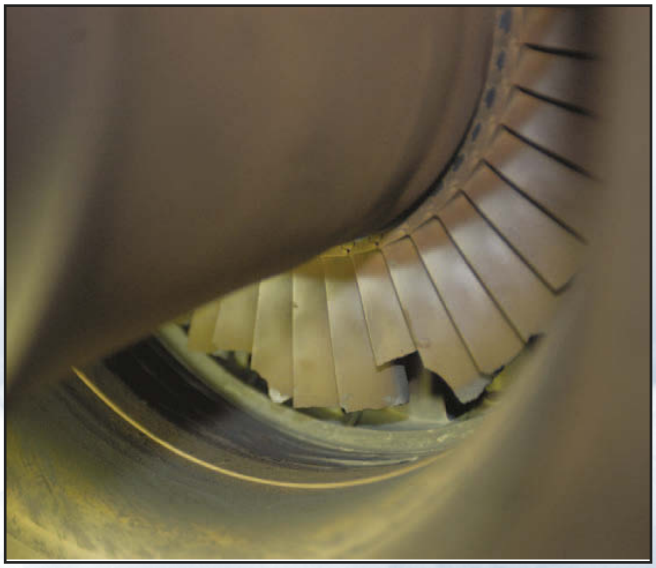
The investigation determined that this accident was caused when the critical step of rolling the number two throttle to flight idle prior to switching the engine governor to manual was missed. The consequence of this omission was that unmetered fuel was fed into the engine combustion chamber which resulted in extensive heat damage.

A breakdown in crew resource management (CRM – now HPMA) protocols amongst the pilot, co-pilot and flight engineer contributed to this occurrence. Checklist memory items were missed, and verbal confirmations of cockpit instrumentation readings were communicated without visual verification. Additionally, the investigation determined that a cockpit authority gradient existed which affected the flow of information during a critical stage of flight.

Outstanding safety recommendations include emphasized training in HPMA to address information gathering and verification processes, as well as assertive crew communication principles.

Additionally, a re-emphasis on checklist "bold print" emergency procedure discipline was recommended. Finally, an amendment to the checklist to provide a more positive control step to the "governor failure" procedure was also recommended. ◆





EPILOGUE

TYPE: *Schweizer* **2-33A C-GCSD**
LOCATION: **Debert, Nova Scotia**
DATE: **14 August 2003**

The student pilot was conducting a solo flight in the Atlantic Regional Gliding School program. After upper area manoeuvres, the student pilot entered left downwind lower than the recommended height to compensate for updrafts that were encountered during previous flights. Due to the crosswind and sink conditions that had developed in the short time since the last flight, the glider was lower and in a wider pattern than normal. The glider became critically low while on base leg, and when attempting to turn final, it struck a large tree on the airfield perimeter. The student pilot suffered minor injuries. The glider received "A" category damage.

The investigation focused on the training the student had received and found an irregular training pattern with frequent no-fly periods, lasting up to 10 days, mostly due to weather. The student pilot also flew with eight different instructors on 13 flying days spread over 38 calendar days. It is assessed that this training pattern was not conducive to continued progress or effective motivation. With this particular student pilot, because of the number of instructor changes, it was difficult to establish a sound student/instructor relationship in which the instructor would have been allowed to detect difficulties and to provide solutions. As well, deficiencies were noted in the progress monitoring and instructional procedures used during the student's training.

The investigation determined that the student pilot used an improper technique and did not apply proper wind drift correction for the sudden and significant wind change during the solo trip. It is assessed that the student pilot did not possess the pre-requisite capability and knowledge to assess the new visual and physical cues associated with the wind change.

Since this accident, the Air Cadet Standards and Evaluation Team (SET) has been established at Central Flying School. It is believed that this centralized oversight has already greatly enhanced Air Cadet Glider Training. With the support of Air Cadet standards personnel and line instructors, it is anticipated that the SET will help improve not only flight safety but also the overall quality of an already very efficient program. ◆

EPILOGUE

TYPE: ***Griffon* CH146434**
LOCATION: **Valcartier, Quebec**
DATE: **28 August 2003**

The aircraft was on a tasked mission in support of the Canadian Forces Skyhawks Parachute Demonstration Team. The aircraft climbed to 10,000 feet ASL with all doors closed. Approaching the planned altitude, both cargo doors were opened for the jump sequence, which was uneventful.

The flying pilot then initiated a left hand descending turn at about 80 knots indicated airspeed (KIAS) as the flight engineer (FE) closed the right hand (RH) cargo door. The FE observed the LH cargo door departing the aircraft just as he was reaching over the left side of the aircraft to close it.

The aircraft continued its descent and landed at the helipad without further incident.

Following shut down, the crew noticed that all four main rotor blades were substantially damaged. Furthermore, the investigation revealed that after the LH cargo door assembly left the aircraft, it was struck multiple times by the main rotor blades and was cut to pieces and scattered over a wide area. The aircraft sustained "C" category damage as a result of the damage to the main rotor blades.

Flight data recorder (FDR) data shows that the "never-exceed speed" (V_{ne}) was exceeded by 2 knots at the moment the cargo door departed.

Although considered a small speed variation, this V_{ne} exceedance is assessed as a contributing factor to this occurrence.

The investigation revealed that the occurrence cargo door was not rigged properly. Furthermore, the investigation also revealed that the door restraining kit, normally referred as the "door pinned mechanism", was not used for either door. There was no one on the left hand side of the aircraft to guard the cargo door from the time the jumpmaster exited the cabin until the time the door departed the aircraft.

As a result of this occurrence, the CH146 Weapon System Manager (WSM) staff conducted a review of the cargo door rigging procedures and inspection criteria to ensure the information was clarified. Additionally, a warning was added in the Aircraft Operating Instructions (AOIs) to clarify the requirement for the cargo door to be held or guarded by a crew member during the opening and closing process until the door is properly opened to a pinned position or closed to a locked position.

In summary, this occurrence had significant potential for much more serious consequences. The operational staff at 1 Canadian Air Division Headquarters, the CH146 WSM and various staff from DGAEPM were very proactive in researching the issues and putting in place effective preventative measures to reduce the risk of a re-occurrence. As a result, most of the recommended safety measures have already been implemented. ◆

FROM THE INVESTIGATOR

TYPE: ***Schweizer* 2-33A C-FZIQ**
LOCATION: **St-Jean, Quebec**
DATE: **19 June 2006**

The accident glider was being towed into wind towards its tie-down position when very heavy rain began along with a sudden increase in wind of up to 40 knots. The glider was being escorted by two cadets "wing walkers" holding each wing by the tip when the accident glider's wings began to rock and lift. The wing walkers shouted at the vehicle driver in an attempt to draw his attention, but the wind, rain, and vehicle noise negated any communications. The glider then suddenly lifted with both wing walkers initially still holding on to the wings. The right hand walker was lifted to approximately five feet in the air, and the left walker approximately one foot before they let go. The glider rose to approximately 20 to 25 feet in the air, and hovered for a few seconds before the towing rope broke. The glider climbed an additional 20 to 30 feet with a sharp nose-up attitude, and then became inverted as it traveled backwards. It impacted the ground, nose down, approximately 200 feet from its initial lift-off point.

On the day of the accident, the glider was engaged in flying activities for the Eastern Region Gliding School Instructor Course. The weather forecast included the probability of thunderstorms during the afternoon

The investigation is focussing on weather briefing and interpretation, field procedures, and operational tempo.

Immediate preventive measures include providing Regional Gliding Schools with the ability to receive timely weather and weather radar information. ◆

FROM THE INVESTIGATOR

TYPE: ***Schweizer* 2-33 C-GBJR**
LOCATION: **Mountain View, Ontario**
DATE: **07 August 2006**

The accident glider pilot was participating in the summer Air Cadet Glider Pilot course at Mountain View, Ontario. This was the glider pilot's second solo flight of the course. He was briefed to release at an altitude of 1,500 feet. The tow plane pilot had been directed to take the solo pilot to 2,500 feet. During the aero-tow, the glider pilot became concerned when the tow plane climbed through 1,500 feet and was still flying away from the airfield. The glider pilot elected to release from the tow aircraft at 1,600 feet and return to the airport. The glider entered the circuit for a landing on the grass strip 24R. On downwind the glider was seen to be lower and closer to the landing area than normal. The airspeed seemed excessive as well. The glider turned onto base leg, again at a lower-than-normal altitude.

On base leg, the glider pilot became distracted by an unlatched, but closed, canopy. While attempting to latch the canopy the glider entered a nose low attitude with slight right wing down. The pilot's instructor, who was monitoring the flight from the ground, was concerned that the right wingtip of the glider may contact the ground and cause the glider to cartwheel. The instructor radioed directions for the solo glider pilot to level the wings. The pilot complied and attempted to land straight ahead on an extended base leg.

The glider contacted the ground in a short field, bounced, and impacted a stand of trees while still airborne. The impact caused severe structural damage, including ripping off the outer 10 feet of the left wing. The fuselage came to rest between two smaller trees. The glider received "A" category damage.

The accident was witnessed by several people who responded and were on the crash scene within minutes. Local Emergency Medical Services were on scene in approximately 15 minutes. The pilot was taken to a local hospital and was released within one hour. The pilot suffered minor injuries. The investigation is looking at a number of issues including communication at the launch point; solo monitor responsibilities; and the training and training records of the solo pilot. ◆

For Professionalism

For Commendable Performance in Flight Safety

MASTER CORPORAL MIKE BAKER

As part of a routine pre-flight inspection of a CH146 *Griffon* in November of 2006, Master Corporal Baker performed a thorough review of the Maintenance Record Set (MRS). While examining the aircraft's basic weight and balance change record, he noticed a discrepancy. A Sleeping Kit (35 lbs) was mistakenly recorded as having been added to the baggage compartment, while Winter Kit A (50 lbs) had been accidentally subtracted from the record, showing an imbalance of 15 pounds.

Upon further investigation, MCpl Baker determined that the aircraft had already been flown with this error on the MRS. He immediately brought this to the attention of the servicing supervisor. An inspection was conducted to ensure that the aircraft was properly configured and the weight and balance records were amended accordingly.

This error had the potential to go unnoticed for a long period of time and required an in-depth review of the record-set to be identified. MCpl Baker's diligence ensured that the error in the weight and balance calculation was swiftly corrected, thereby preventing the carry-over of this miscalculation. His performance is in keeping with the highest standards of flight safety professionalism. ◆

Master Corporal Mike Baker is serving with 403 Squadron, Canadian Forces Base Gagetown.

CORPORAL SHAWNE MCGREGOR

While performing a vibration analysis on the CH146 *Griffon* using the Health and Usage Monitoring System (HUMS), Corporal McGregor recognized a problem during a review of data from the previous day's flight. The tail rotor vibrations on aircraft 410 had climbed into a dangerous range. She immediately informed the servicing desk controller and prevented the aircraft from departing on its intended mission. Cpl McGregor then used her technical knowledge to inspect the tail rotor blades, hub and control system, astutely determining that the trunnion seal had failed, resulting in loss of lubricating grease.

Cpl McGregor's professionalism, technical knowledge and computer savvy prevented the impending failure of the tail rotor system, which could have resulted in control difficulties during future aircraft operations. ◆

Corporal Shawne McGregor is serving with 403 Helicopter Operational Training Squadron, Canadian Forces Base Gagetown.

For Professionalism

For Commendable Performance in Flight Safety

CAPTAIN ROB JOHNSON, CAPTAIN TROY KEARNS AND MASTER CORPORAL BRIAN SCHONEBERG

In March 2006, while flying on an operational search and rescue (SAR) mission, the aircraft captain, Captain Kearns, elected to reduce a fuel imbalance on *Cormorant* CH149907 by cross-feeding fuel from tank one into the number two engine.

To explain, the CH149 *Cormorant* has three engines, which, in the standard configuration, draw fuel from one of three corresponding and separate main fuel tanks. If one main tank contains a lower fuel quantity than the others, the pilot may elect to cross-feed fuel to the corresponding engine from a different main tank to correct the imbalance. The pilot must be attentive during this procedure to avoid the risk of engine flameout. The pilot is presented with a histogram on the electronic systems display presenting fuel system switch selection, fuel flow direction, and fuel remaining in each tank.

After a short period of time, Capt Kearns noticed that the fuel imbalance was increasing. Switch positions were confirmed correct and the diagram of the fuel system flow on the electronic instrument display reflected the physical switch selection. Capt Kearns called on Capt Johnson and MCpl Schoneberg to help troubleshot the situation. They discovered that fuel was in fact flowing opposite to what they had selected.

The post-flight investigation revealed that a faulty servo was wired into the fuel manifold, causing it to perform in reverse. As a result, instead of rectifying a fuel imbalance, the imbalance would be worsened. It was found that this servo had been in place for a number of years. Further investigation revealed deficiencies in contractual supply support and procedures that could have led to incorrect maintenance actions across the entire fleet.

The actions of Capt Kearns, Capt Johnson and MCpl Schoneberg prevented a possible critical fuel imbalance from developing and potential engine flameout from occurring during flight. Additionally, their attention to detail led to the introduction of better critical oversight and new procedures for the validation of parts within the Cormorant supply chain. ◆

Captain Rob Johnson, Captain Troy Kearns and Master Corporal Brian Schoneberg are serving with 442 Squadron, 19 Wing Comox.

WARRANT OFFICER FRANCIS LEVESQUE

In February 2006, *Aurora* CP140102 was scheduled for its first operational mission following a periodic inspection and post-periodic test flights. During his flight engineer pre-flight inspection, Warrant Officer Levesque carried out a bleed air leak acceptance check, though this check is not required for the flight engineer pre-flight. He has a long corporate memory: while on the *Hercules* aircraft in 1982, a *Hercules* from his squadron experienced a bleed air leak in the leading edge that led to extensive and near catastrophic damage. With this in mind, WO Levesque did the check and discovered a significant bleed air leak in the port wing. Upon noting the abnormal indications and carrying out extensive troubleshooting, WO Levesque advised the servicing technicians and assisted them in finding the location of the bleed air leak.

The fault was an improperly seated clamp on the bleed air conduit located in the left hand inboard leading edge between the fuselage and the No. 2 engine. The loss of bleed air would affect important functions such as engine starts and wing de-icing. Furthermore, the hot bleed air escaping from the manifold into the leading edge plenum would expose critical wire bundles and the No. 2 fuel cell to potentially catastrophic heat loads.

As a result of this find, an amendment to the periodic inspection card that would make a bleed air manifold leakage check mandatory was proposed.

WO Levesque's extensive experience on the *Aurora* and *Hercules*, his safety conscious approach, and his professional attitude averted a serious flight safety occurrence or worse. ◆

Warrant Officer Francis Levesque is serving with 407 Maritime Patrol Squadron, 19 Wing Comox.

PRIVATE JOHN DRIEDGER

After the completion of an avionics snag on *Hornet* CF188719, Private Driedger, then an unqualified apprentice with less than three months experience, assisted a fellow technician with the required daily inspection (DI) on the same aircraft. While inspecting the vertical stabilizers, Pte Driedger noticed that the right hand rudder center hinge attachment bolt appeared slightly different than the one on the left hand rudder. It appeared that the lower portion of the bolt was approximately 2-3 mm lower than normal. He immediately informed the qualified technician he was aiding, who confirmed that there was a problem with the bolt and declared the aircraft unserviceable. Upon further investigation, it was found that the bolt was in fact completely sheared and was being held in place only by the lower hinge fairing. Although this particular hinge is inspected during every DI, this condition was not previously noticed. Given the unlikely nature of this type of failure and only a very slight change in outward appearance, this condition would be very difficult to detect during routine DIs, especially for someone with limited experience on the aircraft. Had this un-serviceability not been detected, it could have led to a complete right rudder failure and possible loss of aircraft control while airborne with catastrophic results.

Pte Driedger's professionalism and attention to detail ensured that a relatively minor malfunction did not lead to a major accident. ◆

Private John Driedger is serving with 1 Air Maintenance Squadron, 4 Wing Cold Lake.