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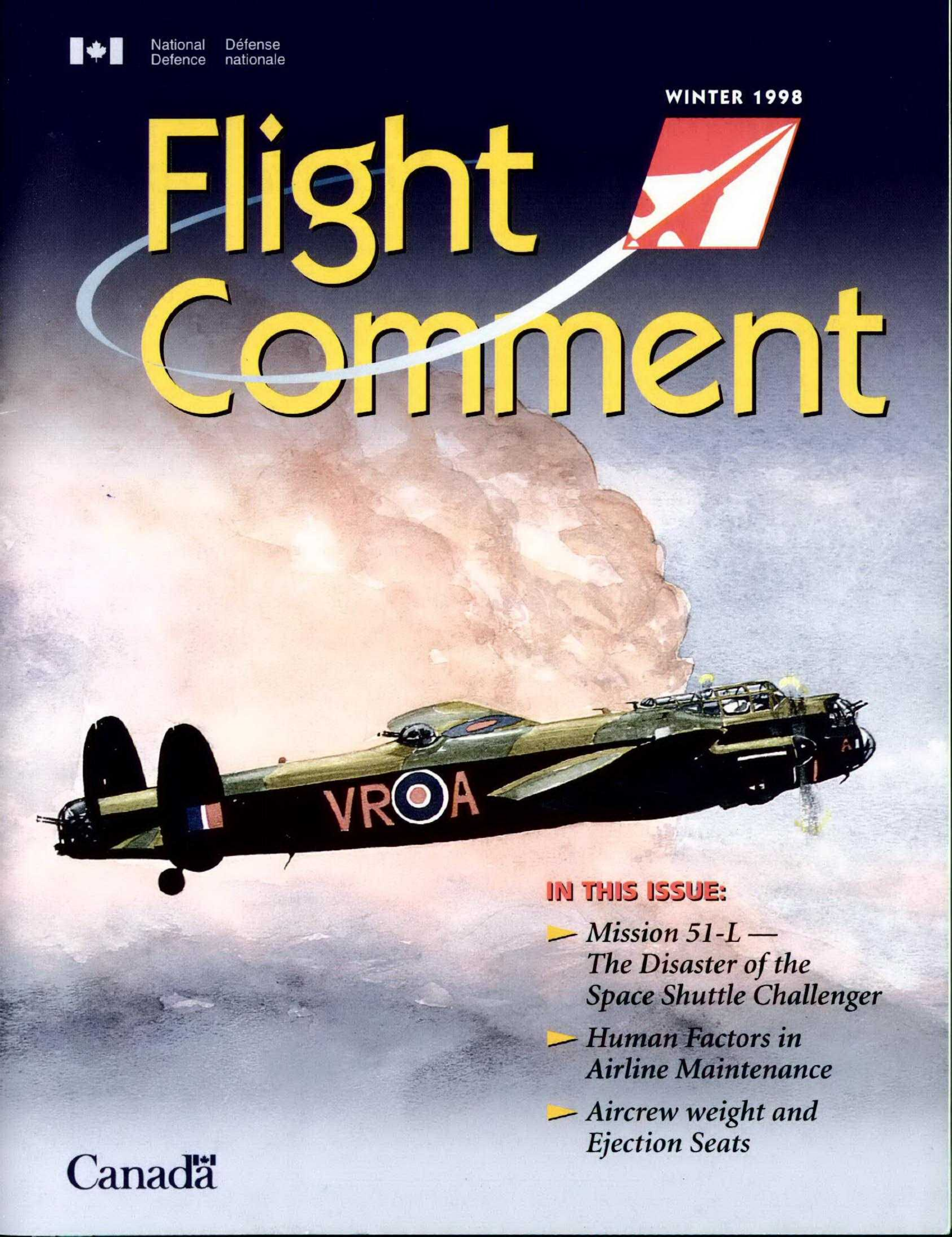
Flight Comment



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Canada

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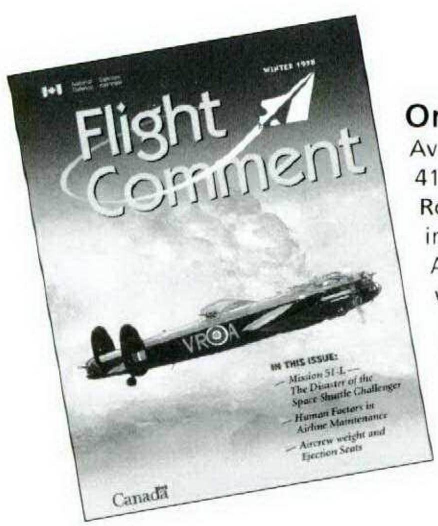

On the Cover:
Avro Lancaster X KB726 of 419 "Moose" Squadron Royal Canadian Air Force in which Pilot Officer Andrew Charles Mynarski won the Victoria Cross. His citation is printed to the right.

Painting by Mr. Roy Ahopelto

Victoria Cross

"PILOT OFFICER MYNARSKI WAS THE MID-UPPER GUNNER OF A LANCASTER AIRCRAFT, DETAILED TO ATTACK A TARGET AT CAMBRAI, FRANCE, ON THE NIGHT OF 12TH JUNE 1944. THE AIRCRAFT WAS ATTACKED FROM BELOW AND ASTERN BY AN ENEMY FIGHTER AND ULTIMATELY CAME DOWN IN FLAMES.

As an immediate result of the attack, both port engines failed. Fire broke out between the mid-upper turret and the rear turret, as well as in the port wing. The flames soon became fierce and the captain ordered the crew to abandon the aircraft.

Pilot Officer Mynarski left his turret and went towards the escape hatch. He then saw that the rear gunner was still in his turret and apparently unable to leave it. The turret was, in fact, immovable, since the hydraulic gear had been put out of action when the port engines failed, and the manual gear had been broken by the gunner in his attempts to escape. Without hesitation, Pilot Officer Mynarski made his way through the flames in an endeavour to reach the rear turret and release the gunner. Whilst so doing, his parachute and his clothing, up to the waist, were set on fire. All his efforts to move the turret and free the gunner were in vain. Eventually the rear gunner clearly indicated to him that there was nothing more he could do and that he should try to save his own life. Pilot Officer Mynarski reluctantly went back through the flames to the escape hatch.

There, as a last gesture to the trapped gunner, he turned towards him, stood to attention in his flaming clothing and saluted, before he jumped out of the aircraft. Pilot Officer Mynarski's descent was seen by French people on the ground. Both his parachute and clothing were on fire. He was found eventually by the French, but was so severely burnt that he died from his injuries.

The rear gunner had a miraculous escape when the aircraft crashed. He subsequently testified that, had Pilot Officer Mynarski not attempted to save his comrade's life, he could have left the aircraft in safety and would, doubtless, have escaped death. Pilot Officer Mynarski must have been fully aware that in trying to free the rear gunner he was almost certain to lose his own life. Despite this, with outstanding courage and complete disregard for his own safety, he went to the rescue. Willingly accepting the danger, Pilot Officer Mynarski lost his life by a most conspicuous act of heroism which called for valour of the highest order.

Flight Comment

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From the Editor

Welcome to the first issue of the new style *Flight Comment* magazine. You'll notice that there is rather more bulk to this issue than before. So why the change? In the its former life *Flight Comment* was published six times per year. Each issue had 16 pages of articles and features in a format that had remained unchanged since the 1960's. With the regular features there simply was not sufficient space to publish the lengthier, more thought-provoking articles which should be included in a journal of flight safety. Something had to give. What have we done? In a nutshell we have doubled the page count per issue while reverting to a quarterly format. The end result is 128 pages available each year versus the old number of 96. You will see some longer articles, while at the same time, most of the old features will remain intact. Who says things don't change for the better? As for the historical precedence – Crash Comment and the earlier issues of *Flight Comment* were published in a quarterly format.

A few remarks about some of what you will see in this issue. Mission 51-L is an excellent analysis of what led up to the fatal decision to launch the space shuttle Challenger. A risk assessment is only as good as the facts on which it is based. We have all heard a lot about risk lately. Terms like "Risk Management" and "Smart Risk" are bandied about with a panacea-like quality. Certainly risk management is a good idea and a useful tool – when used correctly. Let us hope that the concept doesn't simply lead to yet another form that has to be filled out and archived somewhere.

Human Factors in Airline Maintenance deals with a topic I feel we have ignored for all too long. We have focused almost exclusively on human factors in the cockpit; I hope that the article will promote some thought (and perhaps submissions) from those on the floor and in the shops.

As a society on the whole we are getting heavier as time passes (my 100 % polyester mess kit continues to shrink); yet the aircraft we fly have escape systems that were designed when we were a tad bit more svelte. Take a look at your toes and do your own risk assessment – perhaps it's time to stop working out at the DQ. Before you mention anything about "people that live in glass houses shouldn't........" I'm adopting a vigorous training regime on the links, turning a game of skill into a game of endurance.

You'll notice that the historic aircraft profile has been removed from this issue. Why? Well; I've been doing the research for five years now and frankly that is quite enough. If you are interested I'll do a series on Canada's "air" Victoria Crosses or perhaps a series on medals and decorations awarded to Canadian airmen and airwomen. A nice segue into my next topic – articles and letters to the editor. I request and welcome your submissions, comments, praise or brick-bats. I will respond to every letter which I receive and look forward to publishing some of your comments; be they about articles which you have read or the new format of the magazine (stand by for a readers' survey later this year).

I would like to acknowledge the following publications who gave permission to reprint articles: "Flight Deck" the magazine of British Airways Safety Services for " Mission 51L – The Disaster of the Space Shuttle Challenger"; "Forum" the journal of The International Society of Air Safety Investigators for "Human Factors in Airline Maintenance"; "Strike Safe" for "Aircrew Weight and Ejection Seats" and the idea behind the CF version of "Accident Man"; and "Cockpit" the Royal Navy safety magazine for "Mosquito Crash".

I would be remiss in not thanking the outgoing editor, Captain Bill Collier, for keeping his hand on the *Flight Comment* helm so well. On behalf of the Air Force community, and all of us at DFS, thank you for a terrific job. I await your "what have you done to MY magazine?" letter.

Mission 51-L – the disaster of the Space Shuttle Challenger

It is hard to believe that it is now ten years since the world watched in horror as the symbol of the American dream exploded before their eyes. The Space Shuttle Challenger on Mission 51-L was launched at 11:38 am on January 28th 1986. It ended 73 seconds later with a complete structural breakup and the loss of the seven crew members aboard. Sarah Havard reviews some of the pertinent factors which led to this disaster.

The Presidential Commission concluded that the immediate cause of the accident was the failure of the pressure seal – an O-ring – in the aft field joint of the right solid rocket booster. The failure was due to a faulty design unacceptably sensitive to a number of factors. Amongst these factors were the effects of temperature, the physical dimensions and the character of the materials. This conclusion, however, is no more than a description of what happened. As with all accidents it is more beneficial to uncover the underlying reasons as to why such a thing could have occurred; to learn any valuable lessons from a seemingly unnecessary tragedy.

Had the decision makers known all the facts, it is highly unlikely that they would have decided to launch mission 51-l on 28th january.

On the face of it, the decision made surrounding the launch of the Challenger was fundamentally flawed. Those who made this decision were reported as being unaware of the recent history of problems concerning the shuttle's booster field joints and O-rings. Had the decision makers known all the facts, it is highly unlikely that they would have decided to launch Mission 51-L on January 28th and the unnecessary loss of life could have been avoided.

In 1977, in test firings of the solid rocket booster, the contractor engineers from the design company, Thiokol, found that the rocket's casing expanded at ignition to such a degree that the field joints, where the rim of one segment fits into a groove of the segment below, were opening slightly, instead of tightening as they had been designed to do. Thiokol management had managed to convince NASA that this situation was "not desirable, but it is acceptable". This situation has been described by Henry Cooper from NASA as a "reversal of logic"; something that did the exact opposite of what it was approved to do. There were to be many such reversals during the build up to the launch.

The joints between the segments of the solid fuel rocket boosters (known as field joints as they are assembled in the field during the final erection of the booster) were installed with two O-rings – a primary and a secondary – which sealed the joints against the tremendous pressure of hot gases from the burning propellant inside the booster. The O-rings were protected from direct exposure to these gases by strips of an asbestos-filled, zinc chromate putty, the consistency of which varies between tacky and stiff, depending on the ambient temperature. This variability was to prove an important factor as the accident event unfolded.

Under pressure the O-rings were designed to be forced into the gap between the segments; however, the secondary O-ring would often become unseated whereby the redundancy that it was meant to provide was lost. Another reversal of logic?

In November 1981, there occurred what NASA calls "erosion" of one of the six primary field joint O-rings. Erosion, or more literally scorching, was found in the aft field joint of the right hand booster – the same joint that was later involved in the Challenger explosion. Each piece of hardware is categorized by NASA to reflect the direct effect of an item's failure on a shuttle mission; this is known as a criticality rating. In 1982, NASA changed the criticality rating of these field joints to Criticality 1, meaning that was no redundancy and that the failure of the primary O-ring alone could mean catastrophic loss of vehicle and crew.

To make sure that the O-rings and the putty formed a tight seal, NASA conducted a test of the booster rockets before each flight. Each field joint had pressurized air blown into the space between the two rings through apertures in the rocket casing. Before the tenth mission the pressure was doubled and a long scorch was again found on one of the primary O-rings. Despite declaring the joints to be Criticality 1, the "Problem Assessment System Report" read "Remedial action – none required". Just as the gap in the booster joints had become acceptable, so now did the scorching of the primary O-ring. This relaxed attitude to such a significant part was all the more remarkable because to these rocket engineers it went without saying that O-rings should never be exposed to the full heat of the boosters and yet there was real danger of this occurring.

The engineers apparently did not notice the coincidence of the scorching with the increase of pressure. They knew that the increased pressure was somehow breaching the primary O-ring and causing tiny pinholes to appear in the insulating putty. And yet, for some reason they concluded that, far from being unacceptable, that this was evidence that the pressure tests were working and the seals were sound. On the very next flight a phenomenon called "blowby" occurred where one of the primary O-rings was breached altogether but again, remarkably this was deemed acceptable. Blowbys continued to happen, the worst case being where the ambient temperature at the launch was only 51 degrees Fahrenheit. On the morning of the disaster the temperature was only 36 degrees, 15 degrees colder than that of any previous launch. Little or no trend analysis had been performed on the O-ring erosion and blowby problems. Careful analysis of the flight history O-ring performance would have revealed the correlation of O-ring damage and low temperature. Consequently, neither NASA nor Thiokol were prepared to properly evaluate the risks of launching the mission in conditions more extreme than they had encountered before.

"They didn't have the right mechanism in place to detect and stop things. They never moved forward." It was reported that mistakes of this kind might not have happened and been repeated in a more open environment. And so, no attention was paid to this coincidence and no one saw any reason for passing this information on to the management as was the usual procedure in the face of something novel. As the flights continued successfully, and the scorch marks increased in size and number, the degree of damage acceptable had clearly increased as well.

The night before the launch, Allan McDonald, the Chief Engineer from Thiokol, began to have serious misgivings about the effect of low temperatures on the O-rings and advised that the launch be suspended. Some of the engineers from Thiokol believed that the cold could render the O-rings so stiff that they could not properly seal the joints against the hot gases. That evening a conference call was held between the senior personnel from Thiokol, the Kennedy Space Center and the Marshall Space Flight Center. The history of the O-ring erosion and blowby was discussed and Robert Lund, the Vice President of Engineering at Thiokol, recommended not launching until the temperature of the O-ring reached 53 degrees Fahrenheit which was the lowest temperature of any previous flight. The Deputy Director at Marshall was said to be "appalled" by this recommendation. The call was suspended at this point and Thiokol spent the next 30 minutes discussing the issues surrounding the temperature effects on the O-ring. A final management review was held by the top four men from Thiokol and pressure was put on Lund to put on his management hat and not his engineering one. The conclusion was that Thiokol resumed the conference call with NASA and stated that it had reassessed the situation; temperature effects were still a concern but that the data was inconclusive and the launch was therefore recommended.

The night before the launch, the chief engineer from thiokol, began to have serious misgivings about the effect of low temperatures on the - rings and advised that the launch be suspended.

Allan McDonald from Thiokol remained unconvinced and continued to argue for a delay, asking how NASA could rationalize the launch below the recommended temperature. He was advised that this was none of his concern.

In the Commission Report, Curt Graeber suggests that management judgements at this conference call may have been affected by the several days of irregular working and hours and insufficient sleep which had preceded the launch. Time pressure caused by delays to the launch had increased "the potential for sleep loss and judgment errors". He concludes that the "willingness of NASA employees in general to work excessive hours, while admirable, raises serious questions when it jeopardizes job performance, particularly when critical management decisions are at stake". No doubt many people reading this magazine will have found themselves in a similar position – working excessive hours to get the aircraft out on time. Sound familiar? It can be all too easy to underestimate the effects of fatigue on action and judgement.

As an aside, the mission before Challenger very nearly ended in disaster too. Four minutes before the launch of Mission 61-C on 6 January 1986, "18,000 pounds of liquid oxygen were inadvertently drained from the Shuttle External Tank due to operator error. Fortunately, the liquid oxygen flow dropped the main engine inlet temperature below the acceptable limit causing a launch hold, but only 31 seconds before lift off". It was not until the launch hold was called that anyone realized that the liquid oxygen had been dumped. It was reported that this loss of liquid oxygen "could have led to serious safety of flight consequences had the team elected... to proceed with the launch". The investigation revealed that console operators in the launch control centre at Kennedy had misinterpreted system error messages and cited operator fatigue as one of the major factors contributing to the incident.

Experience and success will often breed complacency – it is in this type of climate when vigilance is lacking and defences are lowered that accidents can and will happen.

"As a company goes along and is successful, it assumes that success is inevitable. NASA had a history of 25 years of doing the impossible". This statement from Professor Starbuck at NYU suggests that NASA may have become complacent about their record of safety. The Presidential

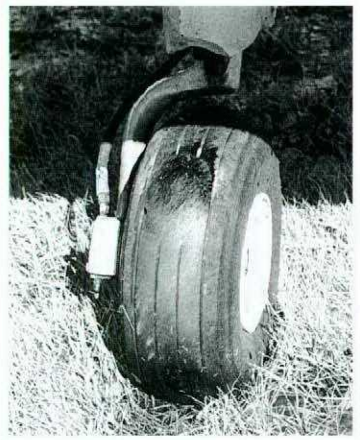
continued on page 7

I Learned About Instructing From That

In my four years as an Instructor flying the Musketeer at 3CFFTS during the mid 80's one of the more mundane duties I had to perform was Tower QFI. As such we were responsible for monitoring the activities of the solo students as they flew their missions either in the circuit or in the Practice Area doing the few Clear Hood sequences they were allowed to practice without the supervision of their instructors. For those solos in the circuit it was easy enough to keep an eye on them, but I never quite figured out how we were supposed to know what was going on out to the west of Portage as those budding aviators explored the wilds of central Manitoba. I'm sure the residents of Edwin, MacGregor, or any of the many farms that occupied the area could tell some stories of what they saw during those flights but to protect us all they would be better left untold.

On this particular day there was only one solo student practicing touch and goes. He happened to be a foreign student who was nearing the end of his fixed wing training prior to moving on to the Basic Helicopter Course. These students followed the regular PFS syllabus initially, and when their course mates moved on to the Tutor in Moose Jaw they continued with more advanced training on the Musketeer.

The runway in use that afternoon was the one right in front of the tower. As a result the ATC controllers and I were treated to an excellent view of the many students on dual trips that were trying their hardest to tame the Musketeer and manage landings that would ensure their continued progress on the course. Every so often the solo student would come around the pattern and demonstrate his ability for us in the tower. As his mission wore on the winds increased in strength and slowly but surely moved off the runway to become a challenging crosswind. As this was happening I was racking my memory to try to remember the crosswind limits for solo students on the Advanced course. As I wasn't one of the few instructors that taught on that course it was not a figure with which I was familiar. I watched as he carried out another successful touch and go and began searching through my copy of the school flying orders in an attempt to find the allowable limit. At that point I heard the voice of the Chief Flying Instructor on the radio



asking clearance for a touch and go. He was on a Clear Hood mission with a student on the regular course. He was right behind the solo student in the circuit. He must surely be aware of the winds and yet he hadn't said anything so everything must still be all right.

During the next few circuits the winds continued to increase and that made my mind up. As I was not supplied a mike, I asked the Air controller to advise the student to make the next landing a full stop when he called at Initial.

The circuit was getting busy as many of the airborne missions were returning in response to the increasing winds. When the solo checked in again at Initial for sequencing, the controller added, "Tower QFI advises to make this a full stop", to the usual information given at that point. I missed his acknowledgment as a transmission from another aircraft cut off the response.

On short final he asked for another touch and go, confirming my suspicion that he had missed the previous call. Once again I asked the controller to advise him to make a full stop. After he did we watched as he again successfully landed right in front of the tower but were surprised to see the nose of his plane pitch down slightly and the aircraft surge forward in response to the application of power for another take-off.

Immediately the controller said, "Bengal 25, Tower QFI advises to make this a full stop". In response he called hesitantly, "Portage Tower, Bengal 25—aaahhhh —say again—?" Before I could intervene the Controller repeated his transmission. By this time the Musketeer was well down the shortest of Portage's inner triangle of runways. I watched helplessly as he closed the throttle and attempted to stop in the remaining distance. He skidded off the end of the runway into the partially frozen overrun wearing a good deal of rubber off the two mainwheels but fortunately remaining upright and pointed in the direction of travel.

The Base's crash response swung smoothly into action. It was quickly ascertained that the student was not injured. The aircraft was towed out of the mud in short order with "D" category damage. It turned out the student completely missed the unexpected input at initial and on final to carry out the full stop. Upon finally understanding the order on the runway he understood it to mean there was something wrong with the plane. Never having aborted a take-off in his short career he was unfamiliar with the distance required to stop the plane or the amount of runway remaining. In any case, he had lost confidence in the aircraft at that point and rightly felt that going off the end of the runway at moderate speed was better than going flying with a possible problem that he did not yet recognize.

Upon reflection and discussion with other instructors afterwards some self-evident truths became apparent to me:

Be prepared for all facets of your assigned duty, however mundane. A phone call to the Flight would have answered my question of what the crosswind limit was for this student.

Students are usually maxed out with just flying the plane when solo especially when on approach. They are not prepared for unexpected inputs when already fully occupied. A call when he was less harried, perhaps on downwind, would have been more successful.

The controller attributed more importance to getting the student to make it a full stop than I did. I did not successfully convey my lack of urgency concerning my message to the controller.

Student training did not include any aircraft performance topics and so the pilot was not aware of the stopping distances needed to carry out an abort. The Flying Instructors Guide was amended accordingly.

This occurrence highlights the importance of clear communication in all aspects of aviation especially in the instructional field. Instructing is difficult enough when you are sitting beside the student and misunderstandings frequently occur. Attempting to instruct by remote control from the tower through a third party is asking for trouble. I learned about instructing from that and so should you. ◆

by Major Kevin McCarthy

Flight Comment

Flight Comment would like to hear from you !!!

We know there are some great experiences out there waiting to be told, so how about writing them down. How are you accomplishing your job or mission safely? Do you have a "Lessons Learned War Story" that others may benefit from? Any new technological advances or new equipment that makes your job or workplace safer? Anything else you can think of that will help "get the word out"! Pictures and/or slides with your submission are appreciated. Do any Wings/Bases/Units/Squadrons/Sections/etc. to want be featured on the cover?

We can be reached by fax, mail or telephone as listed on the inside front cover.

Let's hear from you !!!

G-LOC: 1996 survey results

The following article is a addendum to an article that appeared in Flight Comment issue 3/1996 page 2 titled ***"G-LOC, DOING THE RUBBER CHICKEN"***

by Sonia Latchman, Staff Officer Operational Research, Air Command Headquarters

An anonymous survey of Canadian Forces pilots was conducted by the Operational Research Division last year in order to gather current statistics on G-induced loss of consciousness (G-LOC). The response to the survey was tremendous – 60% of the 1139 successfully distributed questionnaires were returned completed. The results have been published in reference and are summarized below. Because of the high response rate, good representation of aircraft types and pilot experience level, the inference of survey results to the pilot population as a whole is deemed valid.

The survey showed that 15% of pilots who have flown the CT114, CT133, CF116 or CF118 over the last 10.5 years have G-LOC'd at least once during that time – and 15% of those pilots G-LOC'd two or more times. In a 1986 survey, 27% of pilots had reported experiencing at least one G-LOC episode.

Seventy-two percent of the G-LOC episodes occurred in the CT114 Tutor – the aircraft used for Basic and Advanced flight training, and since 1995, for Fighter Lead-in training (FLIT). More than half the CT114 G-LOCs (58%) occurred during aerobatic manoeuvres and a further 27% occurred during the execution of closed patterns (normally a manoeuvre that does not usually involve high G). For the CF188, 81% of G-LOCs occurred during air combat manoeuvres.

The G-levels at which the pilots G-LOC'd ranged from 2.3G to 9.2G (Figure 1). The median was 6.0G for the non-G-suit equipped CT114 and CT133 and was 7.0G for the G-suit equipped CF188 and CF116. This 1G difference can be attributed to the G-suit which increases G-tolerance by 1 to 1.5G. For 16% of CT114 G-LOCs and 38% of CF188 G-LOCs, the manoeuvre was preceded by a period of G less than +1G – a situation which has recently been discovered to decrease a pilot's G-tolerance (called the Push-Pull effect).

Pilots were asked to identify factors that they thought had contributed to their G-LOC episode(s). The most frequently identified factors were the rapid onset of G (69%) and no warning of imminent G (43%). Less than half of the pilots who had G-LOC'd had performed an anti-G straining manoeuvre (AGSM). An AGSM can increase G-tolerances by 4G, if performed optimally.

Table 1 provides some interesting statistics from the 1996 G-LOC survey and compares them to those from the 1986 G-LOC survey conducted by DFS. Overall, 10% of the G-LOC episodes occurred during solo flights, but this varies by aircraft type. For example, over a third of G-LOCs in the CF188 occurred during solo flights. Interestingly, almost half of the G-LOC episodes were preceded by warning signs such as tunneling or loss of vision.

Flying hours reported by all respondents were used to calculate G-LOC rates. The CT114 was found to have the highest rate at 2.8 G-LOC episodes per 10,000 flying hours.

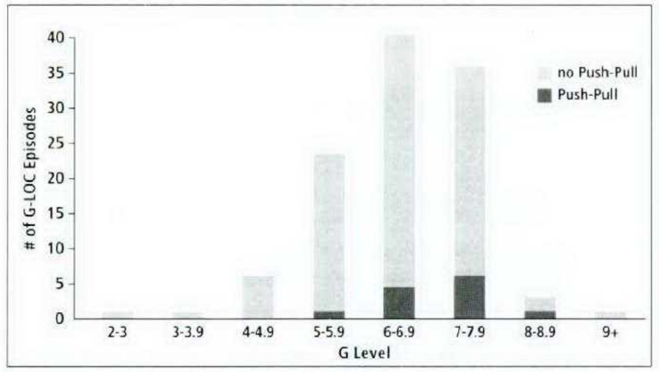


Figure 1: G-Levels attained prior to the G-LOC episodes – 1996 Survey

G-Loc Situation	Year of Survey 1986	1996
The G-Loc'd pilot was the flight controls (with co-pilot in a/c)	22%	14%
The G-Loc occurred during a solo flight	10%	10% overall (6% CT114, 38% CF188, 20% CF116)
G-forces # 5.5 G (the G limit for FLIT)	not in report	37% of CT114 23% of CT133 20% of CF116 0% of CF188

Table 1: Comparison of G-LOC statistics from the 1996 survey with those from the 1986 survey

This rate is approximately one third of what it was in 1986 (see Figure 2).

At the current flying rates, an average of 7, 1.6 and 2.5 G-LOC episodes will occur per year in the CT114, CT133 and CF188 fleets respectively. The decrease in G-LOC rates is encouraging but diligence is still required. G-LOC still occurs and it can be fatal.

Reference: S.A. Latchman, Lt W.S.R. Greenlaw, *The Incidence of G-Induced Loss of Consciousness in the Canadian Forces*, Operational Research Project Report 9602, December 1996. ◆

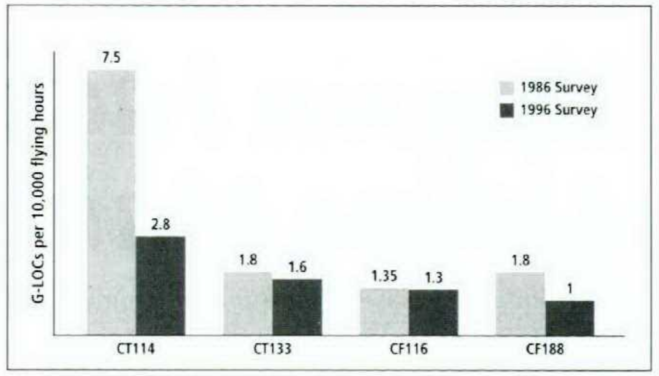


Figure 2: G-LOC rates as determined in 1986 and 1996

Mission 51-L – the disaster of the Space Shuttle Challenger *continued from page 3*

Commission reported that both NASA and Thiokol accepted escalating risk apparently because they "got away with it last time". As Commissioner Feynman observed, the decision making was "a kind of Russian roulette ... [The Shuttle] flies [with O-ring erosion] and nothing happens. Then it is suggested, therefore, that the risk is no longer so high for the next flight. We can lower our standards a little bit because we got away with it last time ..." Experience and success will often breed complacency – it is in this type of climate when vigilance is lacking and defences are lowered that accidents can and will happen.

Coupled with this complacency was a distinct lack of communication between the engineers and the management group. At the inception of the space programme the managers had been technical people who knew the spacecraft intimately. There was a very close relationship between the team at NASA as they all pulled together to achieve the impossible. "In those days, the designers were shoulder to shoulder with the people flying. Somehow, those responsible for design have taken a different path from those operating the shuttle", Joseph Allen, astronaut, commented. "If the people running the system had remembered the lessons of earlier years, the accident would never have happened."

One of the younger astronauts said that he had the feeling that some of the NASA managers had lost sight of the fact that "there were flesh-and-blood people up there" – the ultimate communication gap. Their focus seems to have shifted from the advancement of science and technology to a business orientated programme. There was great pressure
to support an increased flight rate. There were nine missions in 1985; twenty-four missions were projected for 1990. This pressure may have contributed to a tendency to "fudge" problems that might have interfered with the schedule as payloads from the commercial sector were driving the frequency and timing of these flights. The lack of funding from the government ultimately led to cost-cutting though it is impossible to say to what extent building a space shuttle on the cheap contributed to the Challenger accident. "The pressure on NASA to achieve planned flight rates was so pervasive that it undoubtedly adversely affected attitudes regarding safety... Operating pressures were causing an increase in unsafe practices."

Because of the failure of communication and the apparent lack of understanding of what was at stake, the Presidential Commission recommended personnel changes, using more astronauts and retired astronauts in management positions; after all, astronauts are guaranteed to be aware of the risks involved.

"None of these folks that decided to fly Challenger wanted those people to die. None of them in their hearts would acknowledge that they were doing something stupid, evil or rotten. We're not talking about murderers. We're talking about people who took a desperately high risk with other people's money, other people's property, other people's lives hoping like hell that the good luck that had always attended NASA activities would hold." There comes a point when hope and good luck just aren't enough.

Information taken from the Report of the Presidential Commission on the Space Shuttle Challenger Accident (1986) vol.1 and Appendix G – Human Factors Analysis and "Letter from the Space Center" by HSF Cooper, published in November 1987 in the New Yorker. ◆

Sara Havard Human Factors Consultant, British Airways Engineering

Human Factors in Airline Maintenance

***Alan Hobbes*, Air Safety Investigator (Human Performance) BASI**

On 11 September 1991, Continental Express flight 2574 was on descent into Houston Texas on the return leg of a Houston-Laredo service. On board the Embraer Brasilia were 11 passengers, the two flight crew and a flight attendant. As the aircraft descended through 11,800 ft, the leading edge of the left horizontal stabilizer separated from the aircraft. As a result of the aerodynamic disruption, the aircraft pitched down and broke up in flight. All 14 persons aboard were fatally injured.

As the investigation progressed, attention focused on the maintenance of the aircraft. The night before the accident, work had been carried out on the Brasilia's 'T-tail', involving the replacement of de-ice boots on the leading edge of the horizontal stabilizer. The work was only partially completed when a shift change occurred. The screws holding the de-ice boot to the upper surface of the left horizontal stabilizer had been removed in anticipation that the de-ice boot would be changed. However, the screws on the lower surface had been left in place. Workers on the incoming shift were not aware that any screws had been removed from the left side of the tail and apparently did not see the bag of removed screws which had been left near the aircraft. Due to time constraints, it was decided to replace the left de-ice boot at a later date and the aircraft was signed back into service with the upper screws missing. The flight crew would not have been able to see the upper surface of the horizontal stabilizer during the morning preflight check.

The National Transportation Safety Board investigation identified deficient maintenance practices within the airline and raised concerns about the adequacy of FAA surveillance of airline maintenance.[1]

The number-two safety issue

Human error in maintenance is only just beginning to receive the attention it deserves. Air safety statistics frequently list maintenance as a minor causal factor in airline accidents. Yet, when safety issues are presented alongside the fatalities which have resulted from them on worldwide airline operations, maintenance and inspection emerges as the number-two safety issue after controlled flight into terrain (see fig. 1). Maintenance lapses are not just costly in terms of life and property, but can also cost an airline dearly as aircraft are delayed, diverted and turned back.

In one of the few attempts to analyze the types of errors which occur in maintenance, the UK CAA has reported that in a three-year period, the top eight maintenance problems affecting aircraft over 5,700 kg were:

1. incorrect installation of components;
2. the fitting of wrong parts;
3. electrical wiring discrepancies (including cross-connections);
4. loose objects (tools etc.) left in the aircraft;
5. inadequate lubrication;
6. cowlings, access panels and fairings not secured;
7. fuel/oil caps and refuel panels not secured: and
8. landing gear ground lock pins not removed before departure.[2]

The following examples illustrate how apparently simple maintenance oversights can contribute to major disasters.

In 1991, a Canadian-registered DC-8 departed Jeddah, Saudi Arabia, with two under-inflated tires. Although several maintenance personnel knew of the low tire pressures, they were not aware of the hazards of operating at low tire pressures. During the take-off run, two tires failed, igniting rubber fragments still attached to the wheel. When the landing gear was retracted the fire spread to the wheel well and eventually burnt through control systems. The crew lost control of the aircraft as they attempted to return to the airport for an emergency landing. All 261 aboard were killed.[3]

In June 1990, the windscreen of a British Airways BAC 1-11 blew out as the aircraft climbed through 17,300 ft. The accident was traced to the incorrect installation of a new windscreen during the night shift before the flight. The windscreen had been installed by a shift maintenance manager using incorrect bolts.[4]

Yet listing the physical descriptions of what happened does not assist in understanding why these events occurred.

Maintenance-the challenge

As the aviation industry begins to look at the human factors which affect the quality of airline maintenance, it is becoming apparent that maintenance faces some special challenges.

In the early days of flight, pilots endured noise, wind and extreme temperatures as an accepted part of aviation. Maintenance technicians must still contend with the elements in ways that few airline pilots are required to do. A maintenance worker may be required to perch high above the ground, perhaps in rain and darkness, communicating by hand signals through deafening noise.

Maintenance is different in other ways as well. An air traffic controller can unplug from the console at the end of the day, knowing that the day's work is finished. When the flight crew leave the aircraft at the end of a flight, the chances are that any mistakes they made affected that flight only (unless they damaged the aircraft). But when maintenance personnel head home at the end of their shift, they know that the work they performed will be relied on by crew and passengers for days, weeks or even years into the future.

Maintenance personnel are called upon to solve a diverse range of problems. Diagnosing a problem on the basis of a sketchy report by a pilot can call for creative thinking and experience. But creative thinking can sometimes create new, unexpected problems.

To illustrate—in May 1979, an American Airlines DC-10 crashed shortly after taking off from Chicago. At rotation, the number-one engine and pylon broke away from the wing, severing hydraulic lines. As the aircraft climbed away, hydraulic fluid was lost, and the outboard slats on the left wing retracted, while the slats on the right wing remained extended. The aircraft rolled to the left and descended into the ground. All 271 people on board and two people on the ground were killed.

The engine pylon had failed as a result of a fracture that was attributed to maintenance practices at the airline. Although the manufacturer specified that the engine and pylon should be removed separately, the airline had developed a one-step maintenance procedure in which the engine and pylon were removed as one unit. This not only saved about 200 person hours of labour, but was also considered safer as it reduced the number of fuel lines, hydraulic lines and wires which needed to be disconnected. The procedure adopted by the airline involved supporting the engine with the use of a fork lift.

The safe completion of the procedure relied upon accurate movement of the fork lift to avoid damaging the pylon and its attachment points. Unfortunately, the engineers who wrote the procedure were not aware that the fork lift could not be controlled with sufficient accuracy. The engineers never observed the entire procedure being performed by maintenance personnel and were not aware that the procedure was more difficult than planned.

Safety Issues Versus Onboard Fatalities Worldwide (1982-1991)

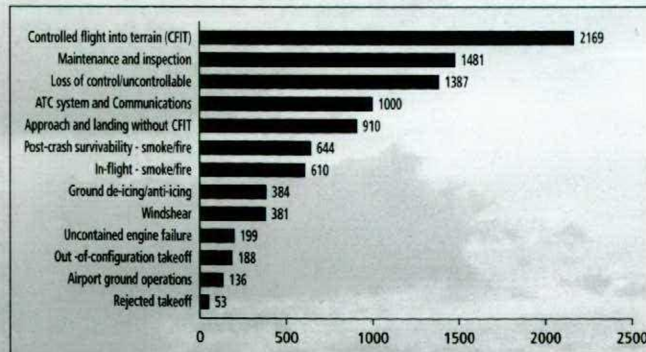


Figure 1

Source: Boeing

In the year before the accident, another airline using the same procedure had damaged engine pylons, yet the damage had been blamed on 'maintenance error'. The cause of the problem was not fully investigated and the damage was not reported to the FAA.[5]

Many maintenance tasks are too large to be completed in a single shift and the resulting handover is a significant challenge to job quality. Paperwork generally ensures a seamless continuity of work tasks; however, cross-shift misunderstandings can still occur. The Brasilia accident described at the beginning of this article illustrates the dangers inherent in shift hand-overs.

Maintenance is driven by paperwork. Although the maintenance manual and task cards specify the procedures to be followed, there is the potential for a divergence between the procedures on paper and the way the job is actually performed. Reducing the gap between procedures and practice is not just a matter of making workers do the work 'by the book'; it is also necessary to ensure that the procedures are realistic and as convenient as possible. Informal work practices or 'norms' often replace cumbersome or unworkable standard procedures. Because norms are not documented and rely on assumptions about 'the way we do things around here', deviation from an expected norm can be as dangerous as deviation from a formal procedure.

While checklists have become essential aids to flight crew, maintenance has come to rely on the sign-off of task cards and other documentation as an assurance that work has been satisfactorily completed. While there are benefits in this system, there are a number of potential problems, including the risk of 'serial sign-off' where a large number of tasks, some possibly incomplete, are signed off at once.

At most airlines, maintenance managers are faced with the challenge of coordinating the work of diverse work teams. Crew resource management (CRM) is an essential element of *flight crew* performance. Yet flight crew do not in general have to coordinate with other crews in the source of a flight. But an aircraft on the ground may be worked on by several maintenance crews simultaneously. Maintenance faces all the problems of coordination of work within crews, but also faces the potentially greater challenge of coordinating work between crews.

Finally, maintenance workers must contend with shiftwork and fatigue without the benefit of duty-time limitations.

Organizational problems

There is no simple way of ensuring that maintenance errors will not occur. However, an important stop towards maintenance safety is the recognition that maintenance quality lapses may be indicators of wider organizational problems.

Organizational factors were exposed in 1983 when a US-operated L-1011 experienced a triple engine failure. The aircraft was en route from Florida to the Bahamas. On descent to the destination, the low oil pressure warning light on the number-two engine illuminated and after shutting

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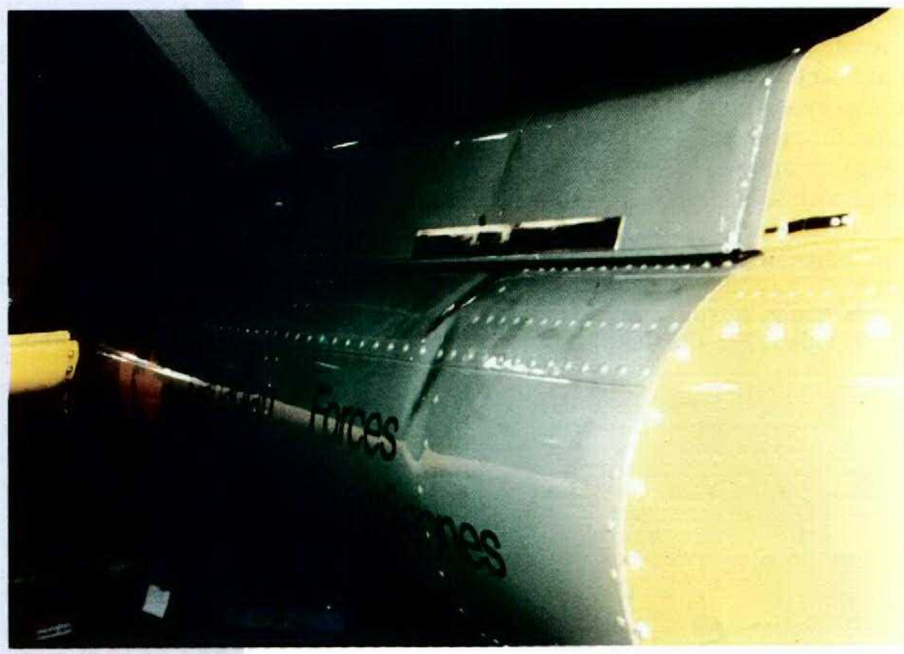
From the Investigator

Aircraft Accident Summary
10 July 1997
TYPE: Jet Ranger CH139306
LOCATION: Portage la Prairie, Manitoba
DATE: 11 June 1996

On 11 June 96 Jet Ranger CH139306 suffered 'B' Category damage following a hard landing during night autorotation training at Portage la Prairie. The mission was a Night Lesson Plan 1, with the instructor as Aircraft Commander (AC) in the left seat and Co-Pilot (student) in the right seat. During an attempted overshoot from a demonstration autorotation the aircraft touched down hard in a nose low attitude, bounced and came to rest about 170 feet short of the Pad 2 landing area. The investigation into the accident is now complete.

Wind conditions for night autos to touchdown were marginal for the accident evening. The instructor had set up the Practice Forced Landing (PFL) lane at the beginning of the trip and thought the wind was within limits. As he rejoined the PFL pattern, the instructor was occupied with his briefing to the student on the auto to touchdown. The information from the tower about calm winds was missed by both pilots. The aircraft in the circuit ahead of them were conducting autos to overshoot terminating in the hover. The instructor thought they were doing autos to touchdown. These factors all contributed to his conducting autos to touchdown when the wind was actually below limits.



Skin Wrinkle – Right side

Investigation revealed that the pilot's proficiency levels for night autorotations had degraded due to service and self-imposed demands. BHS had a history of inherent problems handling a high student load with the number of trained instructors at the unit. In fact, the school had been trying for some time to address the shortages in manpower and heavy course loads affecting the helicopter side of 3 CFFTS operations. The instructor/student ratio and lack of trained instructors over time contributed to the pilot's reduced performance level. This situation played a part in the chain of events leading to this accident by imposing on the school and more specifically the instructor, a larger task load thereby reducing his opportunities to maintain a proper level of flying proficiency.

As a result of this accident AIRCOM initiated a risk assessment study for the conduct of night autorotations and will continue to monitor course loading at 3CFFTS to ensure optimum student/staff levels are maintained. This was also one of several recent accidents in which a lack of supervisory experience was a contributing factor. As a consequence, AIRCOM is looking at re-instituting some form of Flying Supervisors Course which would be a prerequisite for personnel posted to supervisory positions. ◆

Aircraft Accident Summary
28 May 1997
TYPE: POLARIS CC15005
LOCATION: Vancouver, BC
DATE: 26 Oct 95

Under the control of Canadian Airlines International's (CAI) Heavy Maintenance Section in Vancouver, aircraft CC15005, was scheduled for an engine power assurance check near the conclusion of a maintenance inspection during which the engines and pylons had been removed, modified and reinstalled. The run-up proceeded normally until the aircraft rolled over its chocks traveled 720 feet and struck a ground equipment storage building in its path. The run-up crew egressed the aircraft without incident. There were no injuries.

During engine start it was noted that the #2 engine fuel flow gauge was giving erroneous readings. A print out of this information should have been available from the aircraft's Automatic Communication and Reporting System but this system was also unreliable. Faced with these nagging unserviceabilities the crew sought another method of obtaining the required fuel flow reading. This information would also be available on the Cruise Page of the Cockpit Video Display, but this selection was only accessible in flight. The challenge then was to make the aircraft think it was airborne. As a result, during the 40% power check (69.9% N1), the tech-in-charge asked that the "flight/ground circuit breakers" be pulled. Unfortunately the technician's knowledge of the effect of pulling the circuit breakers was incomplete. In addition to not displaying the Cruise Page, pulling these circuit breakers also disabled normal braking, thrust reversers and nose wheel steering.

The run-up checklist called for the aircraft to be chocked using large run-up chocks. As these chocks were unavailable at CAI's maintenance facility, smaller parking chocks were used instead. The combination of these smaller chocks, lack of wheel brakes and a high power setting resulted in the aircraft jumping over the chocks and accelerating across the ramp. Idle power was immediately selected but as the aircraft thought it was airborne the engines went to flight idle which was considerably greater than ground idle. The crew's efforts to control the aircraft were unsuccessful due to the many systems that were not functional while in the flight mode.

Several latent factors compounded the actions of the crew members. They included lack of proper run-up chocks at this maintenance facility and insufficient run-up training that did not include breakaway recovery procedures. Weak incident reporting procedures at CAI led to maintenance personnel believing that maintenance incidents were not reportable to the company flight safety program. As a result, although several company personnel were aware of a similar incident where a CAI A310 had slid against its chocks a few years earlier when the same circuit breakers had been pulled, the incident had not been reported and no effective action to prevent recurrence had been taken.

To correct the problems identified in this investigation, run-up techs are now trained in breakaway procedures, proper run-up chocks have been obtained, and more emphasis has been placed on incident reporting to ensure maintenance occurrences are reported. As well the maintenance manual has been amended to include a warning that pulling the flight/ground circuit breakers will interrupt the normal operation of the brakes. ◆

From the Investigator

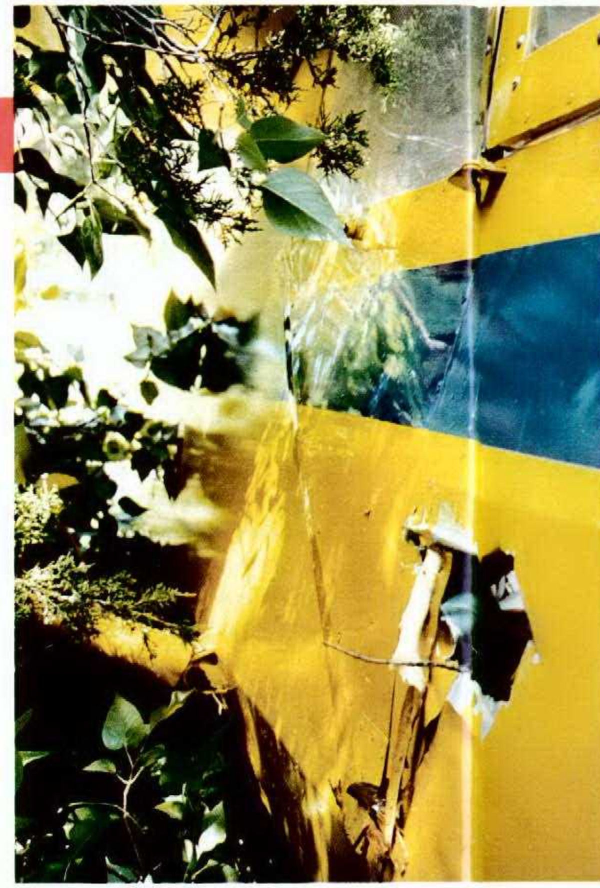
Aircraft Accident Summary
28 May 1997
TYPE: AIR CADET GLIDER C-GIIB
LOCATION: Picton, ON
DATE: 29 Jul 96

The occurrence took place on approach to the Picton Airport which is approximately 20 miles south of 8 Wing Trenton, ON.
On 29 Jul 96, during the course of a normal student solo training mission C-GIIB landed 2200 feet short of the Glider Operating Area. The pilot was not injured.

The student was initially high abeam the launch point and used sideslip and spoilers to correct. He was late turning onto the base leg, thereby placing the glider outside the normal traffic pattern. He then encountered sink due to a down draft at a point in the circuit where the terrain sloped downwards. Despite many calls from the LCO to retract his spoilers the student did not react and the glider descended quickly to a low altitude. The glider struck a tree with low forward speed and it slid down the trunk, coming to rest in a small clearing. The category of damage was initially assessed as "B" Cat but was later downgraded to "D" Cat after a more careful inspection and discussion with Flight Safety personnel.

The student pilot's instructor and the Launch Control Officer (LCO) were monitoring the progress of the flight. They noticed the excessive sink rate and that he was drifting out on base leg. When the glider eventually turned towards the field to correct for the drift, they saw that the spoilers were deployed. The LCO radioed for him to close them. The pilot ignored this call as he was concentrating on transiting the area of sink and was confident that his spoilers were retracted. A second transmission by the LCO, directed specifically to him, resulted in the student answering that his spoilers were already retracted. Only after a third transmission did witnesses finally see the spoilers retract. At this point an
off-field landing was inevitable.

The investigation concluded that the student pilot forgot to close his spoilers after using them to lose the excess altitude he had on downwind. This active cause (technique) was compounded by two other latent causes (communications and channelized attention) which were assessed as a result of the unsuccessful attempt by the LCO to contact the student and the student's certainty that the excessive rate of descent was solely due to the downdraft.



While not causal, the investigation also revealed that the option of an off-field landing is not emphasized during student training as most Air Cadet gliding is conducted in close proximity to an airport. SSO Air Cadets Central Region will enhance training of this option in the future. As well, the On Site Commander of the Gliding site had not specifically designated another person to carry out his supervisory responsibilities while he was away from the launch point for a brief time. While the physical presence of the On Site Commander at the launch point is neither continuously required nor expected, the supervisory function must always be carried out. This has been identified as an ongoing problem as staff rotates through the system. This requirement will again be addressed during indoctrination briefings before the next gliding season and monitored closely by SSO Air Cadets Central Region. ◆

Aircraft Accident Summary
28 May 1997
TYPE: AIR CADET GLIDER C-GCLW
LOCATION: 15 Wing Moose Jaw, SK
DATE: 7 Sep 96

The occurrence took place at the Moose Jaw Gliding Site, which is located at 15 Wing Moose Jaw. On 7 Sep 96, during the course of the Fall Familiarization Gliding Program, a winch operator received serious injuries to his hand when it was trapped between the winch cable and the drum. The glider was not directly involved in the accident and its number is used for record keeping purposes only.

After a normal launch the glider was released and the cable descended and landed in front of the winch. The driver of the retrieval vehicle drove onto the field and attached the cable to the vehicle in order to return it to the launch site. While the vehicle was driving over some uneven terrain the cable became disconnected and the driver stopped to reconnect it. After reattaching the cable and confirming that there was no signal from the winch operator. the driver continued with the retrieval. Shortly afterwards the cable once again became disconnected and the driver noticed the winch operator was signalling for him to return.

Meanwhile at the winch, the operator was not in the cab when the cable initially became disconnected and therefore did not apply the drum brake when the cable went slack. As a result the drum continued to spin expelling cable as it slowed. This resulted in a tangle of cable in front of the winch which the operator was attempting to rectify when the driver reattached the cable and drove off. The operator's hand was trapped between the cable and the drum and his thumb was severed.

The investigation concluded that the accident occurred as a result of the operator not remaining in the cab of the winch during the retrieve (active failure) compounded by the lack of communication between the driver of the retrieve vehicle and the winch operator (latent failure). Region Flying Orders required that comms be maintained using radios but in this case the gliding site was not issued sufficient resources to have a radio for the retrieval vehicle. As well, Site Supervisors did not enforce the rule that the winch operator remain in the cab during retrieval operations.

As a result of this accident the Region will ensure that sufficient radios are issued to all gliding sites. The Wing Commander in Moose Jaw will also increase the Flight Safety support this site receives from Wing Flight Safety Staff. ◆

Aircraft Accident Summary
30 May 1997
TYPE: CF188714
LOCATION: CFB COLD LAKE
DATE: 5 Jul 95

CF188714 departed CFB Cold Lake on the morning of 5 Jul 95 as the number two aircraft in a three-plane CF18 formation. The purpose of the flight was to conduct 2 v 1 and 1 v 1 air combat training. The formation completed four defensive setups prior to the mishap engagement. After the fourth defensive engagement, the #3 aircraft was cleared to return to base while the Lead and his wingman continued with a pre-briefed 1 v 1 scenario.

Following a standard butterfly split, the two aircraft turned head-on and established a left-to-left pass with the #2 aircraft approaching from above. Just prior to the merge Lead advised #2 that he had lost visual contact. This transmission was acknowledged by #2, who continued his attack in accordance with the training rules. The mishap pilot initiated a 6.4 G_z "Split-S" turn from above the Lead aircraft. Prior to completing this turn and with the aircraft nose 40 degrees below the horizon, radial acceleration (G_z) was relaxed and the aircraft rolled to an inverted, nose low, attitude. The aircraft gathered speed as the dive angle steepened, and impacted the ground in a near vertical attitude at approximately 700 KCAS, or Mach 1.12. The pilot did not eject and was fatally injured. The aircraft sustained "A" category damage.

The aircraft was serviceable prior to impact and visibility was good, with a clear and definite horizon. The flight profile was consistent with G_z-induced loss of consciousness (G-LOC) and the investigation focused on the pre-crash physiological environment experienced by the mishap pilot. Data recorded by the Cold Lake Air Combat Manoeuvring Range (ACMR) revealed that the pilot experienced approximately 8 seconds of relative negative G_z immediately prior to commencing the "Split-S" manoeuvre. It is estimated that this "push-pull" effect reduced the pilot's G_z tolerance by approximately 2.9 G_z. An improperly fitted G-suit reduced the pilot's G_z tolerance by an additional 0.1 G_z.

The quality of the mishap pilot's anti-G_z Straining Manoeuvre (AGSM) was assessed by using in-flight audio recording from a recent previous flight and video recordings of the pilot's anti-G_z training course. In both cases, aviation physiology experts assessed the pilot's AGSM technique as sub-optimal. Training records revealed that an ineffective AGSM led to G-LOC in the DCIEM centrifuge during the pilot's anti-G_z training course. Further analysis demonstrated that a 100% efficient AGSM would have allowed the pilot to compensate for the reduction in G_z tolerance caused by push-pull effect and an improperly fitted G-suit. That was not the case in this tragic accident.

Following the accident, AIRCOM issued a revised policy on centrifuge training which established mandatory performance benchmarks and set out reporting and remedial training criteria. DCIEM was tasked to conduct an in-flight research-physiology programme to gain a better understanding of push-pull effect; a recently discovered physiological phenomenon. In an effort to heighten aircrew awareness of this phenomenon, DFS produced a video on the subject of push-pull effect and distributed it to flying units. Finally, the design, testing and production programme for the new "STING" anti-G_z pants was accelerated. ◆

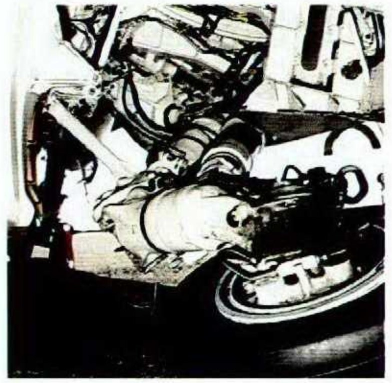
Aircraft Accident Summary
28 August 1997
TYPE: CF188928
LOCATION: 4 Wing Cold Lake
DATE: 22 Aug 95

On 22 Aug 95, Hornet CF188928 experienced a gear malfunction on landing at CFB Cold Lake. The investigation into this accident has been completed.

The aircraft, a two-seat CF-18 with an instructor pilot in the rear cockpit and a student pilot in the front, was returning from a routine student training mission. The approach to land was normal; however, shortly after touchdown the pilots felt the right wing of the aircraft begin to settle and were alerted to a problem by the sounding of the landing gear warning tone. In addition, the warning light in the landing gear selector lever illuminated while the right main landing gear light extinguished, giving the aircrew a definite indication of an unsafe right hand main landing gear (RH MLG). The landing was continued and, as the front seat pilot applied aileron in an attempt to prevent the right wing from striking the runway while at high speed, the rear seat pilot advised air traffic control of the emergency situation. Aircraft directional control was maintained for approximately 4500 feet, at which point the right wheel rim began to dig into the runway surface causing the aircraft to violently rotate through approximately 270 degrees of turn. Following this manoeuvre, the aircraft then came to a full stop on the runway and the engines were shut down. The aircrew conducted an emergency ground egress and were not injured in the mishap while the aircraft sustained "C" category damage.

This aircraft had recently been modified with the new, more robust planing links that incorporate nested external compression springs. Of particular interest to the investigation was the planing assembly connecting link that was found bent, the side brace upper jury link that was fractured at the two lower lags and the initial oscillating RH tire tread marks – or shimmy – immediately after touchdown. Subsequent laboratory analysis determined that the connecting link failed first in compression, permitting the planing arm to unlock and the MLG to shimmy, thereby producing large lateral loads on the side brace. This, combined with excessive freeplay in the side brace and the lower strength aluminum upper jury link, resulted in the failure of the side brace and subsequent collapse of the landing gear.

As a result of this accident, the MLG side braces on all CF-18s were inspected for freeplay and wear. The requirements of that special inspection were also incorporated in the new periodic card deck for the aircraft. Furthermore, an already existing plan to replace the current aluminum upper and lower jury links with stronger steel parts was hastened.



Landing gear problems have been an ongoing concern with the CF-18 fleet. While the problems associated with the planing mechanism are well known and documented, they are still not well understood. Consequently, work has been initiated with the landing gear repair and overhaul contractor to provide a detailed analysis of the system's failure modes. To date, this has resulted in the development of an improved rigging procedure that will soon be incorporated into the applicable technical publications. Plans are also underway to issue a special inspection to properly re-rig all CF-18 aircraft. ◆

From the Investigator

Aircraft Accident Summary
16 July 97
TYPE: CT133266
LOCATION: CFB Shearwater
DATE: 27 Jul 1994

CT133266 departed CFB Shearwater on the afternoon of 27 Jul 94 as the number two aircraft in a three-plane T-33 formation. The purpose of the flight was to conduct a flypast for the 434 Squadron Change-of-Command parade. Once airborne, it became apparent that the weather was not suitable for a flypast and the formation obtained an IFR clearance to CFB Greenwood. The revised plan was to burn off fuel enroute to Greenwood before splitting the formation and returning to Shearwater under separate IFR clearances.

The formation completed a TACAN approach at Greenwood, split up in good VFR conditions and obtained separate IFR clearances for the return trip to Shearwater. The accident pilot was cleared to 7000' MSL and the pilot's last transmission was a call to acknowledge level at that altitude. Approximately 90 seconds later ATC detected a 7700 (emergency) transponder code at 5800 feet and shortly after at 5200 feet. A bail out tone was heard and radar contact was lost at 1445 local time. The pilot ejected but was fatally injured. The aircraft sustained "A" category damage.

The accident pilot was above the maximum weight to which the T-33 ejection seat has been tested. There is no evidence, however, to suggest that the pilot's weight contributed to his death. Analysis of the aircraft canopy confirms that it separated from the aircraft properly. Traces of metallic substance and bums and tears in the parachute canopy in two major areas confirm that the front seat contacted the pilot's parachute. The majority of the damage to the parachute occurred during seat-man separation. Approximately 118 square feet of drag surface was lost and there were indications of high speed and low speed fouling. The resulting descent rate was not survivable and all major injuries to the pilot were sustained on ground impact

A modification of the T-33 Rigid Seat Survival Kit (RSSK) deployment handle was introduced in 1982 to prevent aircrew from confusing the RSSK handle with the ejection handle. The modification comprises an orange nylon flap, riveted at one end to the seat bucket and attached to the RSSK with velcro at the other end. The flap modification, which conceals the RSSK handle until seat-man separation, was improperly implemented on the accident aircraft. The surface area of the velcro on the pilot's ejection seat was five times larger than specified in the modification leaflet. A significant shear force was required to separate the RSSK from the scat and it was determined that the pilot would have been rotated toward this force upon seat-man separation. This rotation may have contributed to the seat/parachute interference and parachute fouling.

The investigation concluded that the circumstances leading to the pilot's decision to eject developed rapidly and unexpectedly. The pilot issued no distress call, did not zoom prior to ejection and initiated ejection with one hand rather than two. There was weather in the vicinity that could have been severe enough to cause control problems. Deficiencies associated with the J-8 attitude indicator have been implicated in two previous accidents and the pilot's susceptibility to disorientation may have increased after flying in close formation for almost an hour. However, the investigating team could not demonstrate conclusively that pilot disorientation was the primary cause of this accident

During the ejection sequence, the pilot was sprayed with a molten plastic substance. Microscopic deposits were found on the pilot's helmet visor, upper torso and right hand, and on the inside of the canopy and canopy frame. The spray pattern of these particles strongly suggests that they were deposited by windblast. The chemical composition of the molten deposits was found to be identical to the caulking/sealant which is applied between aircraft structural components. Exhaustive analysis shows that the source of this molten materiel was forward of the cockpit, exposed to intense heat prior to ground impact, and open to the airstream. The nose section of the aircraft was examined and evidence of an intense pre-impact fire was found in stainless steel oxygen fittings. The investigating team concluded that a high-pressure oxygen-fed fire existed in the nose of the aircraft prior to ground impact.

A detailed search of the aircraft wreckage resulted in the identification of all the hinge parts associated with the right armament door, and sections of the door itself. On the left side, only the airframe mounted parts of the left armament door hinges were located. The airframe mounted parts of the left armament door hinges all exhibited signs of twisting, which is characteristic of a door departing in flight. None of the hinge parts associated with the right armament door exhibited signs of twisting. No portions of the left armament door, door latches or door mounted hinges were found in the aircraft wreckage. The investigating team concluded that the left armament door departed the aircraft in flight.

The tip tanks departed the aircraft while it was in flight and it is probable that the pilot jettisoned the tanks moments before he ejected. Although the tip tank ballistics are not reliable, the tank trajectories suggest that they were jettisoned from an aircraft in a steep right bank and with a right rolling moment. The aircraft throttles were selected to idle at impact. Jettisoning tip tanks and reducing airspeed are steps two and three respectively of the emergency procedure associated with armament doors opening in flight. Previous occurrences of armament doors opening in flight confirm that the aircraft often rolls away from the open door. Lateral aircraft rotation is also an unacceptable condition for the T-33 ejection seat and greatly increases the risk of seat-man-parachute interference.

The investigating team concluded that the accident was caused by a high-pressure oxygen leak in the forward oxygen cylinder attachment fitting. An oxygen-fed fire was started by particle impact ignition. The fire burned away the fuselage skin forward of the left armament door latch and allowed ambient air to force open the left armament door. The aircraft immediately departed controlled flight and the pilot carried out a portion of the ARMAMENT DOOR OPENING IN FLIGHT PROCEDURE prior to ejecting. The front seat interfered with the pilot and parachute after seat-man separation and caused catastrophic damage to the parachute. The parachute streamed and the pilot sustained fatal injuries on ground impact

Following the accident, a special inspection (SI) was issued to replace all fittings on the forward oxygen tank of all T-33 aircraft on the next primary inspection. Elbows that are removed will be inspected by QETE. The state of these elbows will determine the course of action to be taken with respect to similar elbows on the other oxygen cylinders in the CT133. After considerable review, Commander AIRCOM determined that the current CT133 escape system is safe and that any ejection within the published envelope is survivable. A maximum nude weight restriction of 250 lbs has been implemented for CT133 pilots. Action will also be taken to procure a larger and more capable parachute for the T-33 aircraft. To prevent the velcro cover over the RSSK handle from interfering in future seat-man separations, the flap was removed from all seats. The RSSK will also be redesigned to re-locate the handle. ◆

From the Investigator

Aircraft Accident Summary
18 Jul 97
TYPE: CH139312
LOCATION: SOUTHPORT MB (Grabber Green)
DATE: 10 March 95

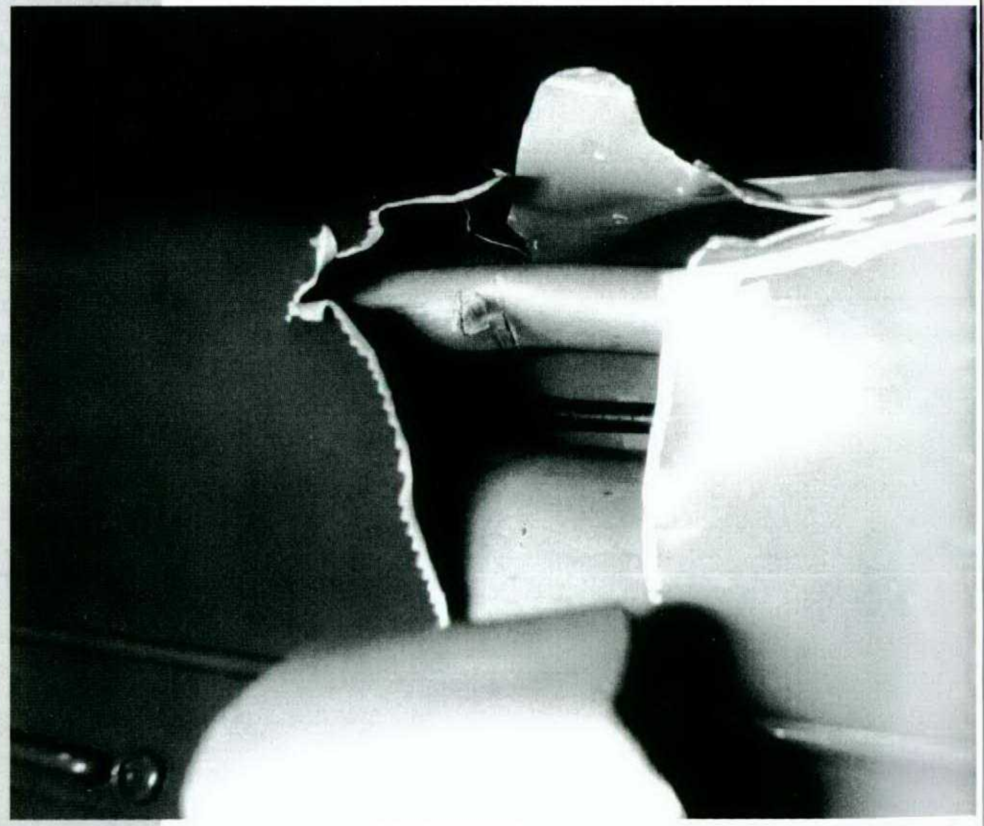
On 10 March 1995 Jet Ranger 139312, CFTMV, received C Category damage after an unsuccessful landing from a modified 180 turning autorotation. The mission was a clearhood mutual with the Aircraft Commander (AC) in the right seat and the Co-pilot (CP) in the left seat. Following one hour of proficiency flying the crew proceeded to Grabber Green to practice autorotations to touchdown. After several circuits the CP took control and proceeded to execute a 180 degree autorotation from below 100 feet AGL. He commenced a steep climbing turn to set up for his landing but was unable to maintain autorotative flight. The overshoot was not successful and the aircraft impacted the ground with some forward speed. The crew egressed without injury. The investigation into the accident has been completed.

Eyewitness reports placed the helicopter at approximately 50-75 AGL during the entry to the accident manoeuvre. The combination of power off, an extremely nose-high attitude and very low airspeed at the apex of the turn caused the helicopter to depart from autorotative flight. The AC called rotor RPM as it decayed through 70% and the co-pilot commenced an overshoot, but insufficient altitude remained for a safe recovery.

Although the CP was flying the aircraft during the accident sequence, the AC should have exercised his authority and terminated the manoeuvre earlier. His belief that the CP had the situation under control was influenced by "halo effect". The AC had implicit faith in the CP because of his Kiowa experience, accumulated instructional time at 3CFFTS and well known ability for handling the aircraft.

Much has been learned in recent years about organizational contributory factors in aircraft accidents. This has helped explain why two qualified and highly experienced individuals attempted a manoeuvre that placed the aircraft outside the flight envelope. The Co-Pilot found instructional flying uninspiring and used mutual and solo proficiency trips to attempt more challenging sequences. Supervisors stated that they were aware of the Co-Pilot's airmanship faults, but no corrective action had been taken prior to the accident.

In response to this accident the School Orders have been amended to include altitude, speed and rotor RPM limits for the 180 degree turning autorotation to ensure that the manoeuvre is completed within a safe flight regime. The DComd of AIRCOM has tasked COS P&T to proceed with the re-institution of the Flying Supervisors Course and DFS is reviewing the feasibility of implementing an aircrew file that would track individual performance throughout a flying career. ◆



Tail Rotor Drive Shaft

Human Factors in Airline Maintenance *continued from page 11*

down that engine, the captain decided to return to Miami on two engines. While returning to Miami, the oil warning lights on the remaining two engines illuminated and at 16,000 ft the number-three engine flamed out, followed five minutes later by the number-one engine. The aircraft descended without power to 4,000 ft, at which point the number-two engine was restarted. A successful one-engine landing was then made at Miami.

The investigation revealed that on all three engines, master chip detectors had been installed without O-rings, allowing oil to leak from the engines in flight. Over a period of 20 months, the airline had experienced 12 separate incidents involving inflight engine shutdowns and unscheduled landings due to problems with O-ring seals and master chip detector installation problems. As the NTSB reported, 'In every incident... management investigated the circumstances and concluded that the problem was with the mechanics and not with the maintenance procedure'.[6] Rather than addressing the wider system problems, the incidents resulted in individual disciplinary action and training.

A deeper investigation by management may have revealed that an informal work practice (or norm) had developed at the airline, whereby mechanics were routinely issued with chip detectors with the O-rings already installed. When an exception to this established norm occurred, and chip detectors were issued without O-rings, the mechanics did not notice that the O-rings were missing.[7]

Of course maintenance engineers must take responsibility for the quality of their work. But blaming workers for complex quality lapses sometimes diverts attention from longstanding organizational problems. In the case of the BAC 1-11 accident referred to earlier, there was evidence that the error of the shift maintenance manager was partly a reflection of failures of management, procedures and the regulatory authority. For example, the procedures for changing a windscreen at the particular airline had few system defences or backstops. No one checked the work of the shift maintenance manager and there was no requirement to pressurize the aircraft on the ground after a windscreen change.

A second organizational flaw which can afflict maintenance organizations is a reluctance to report difficulties or errors, sometimes because errors are seen as insignificant. Yet as has been illustrated earlier, seemingly insignificant problems can have very serious consequences.

What can be done

Having demonstrated that human factors and human error are real threats to the quality of maintenance, it is time to consider what can be done about the problem.

As a first step, it is important to acknowledge that human error is an unavoidable reality. Systems and procedures must be designed to anticipate minor errors and to prevent them from contributing to major problems. For example, designers have a responsibility to produce systems and components which cannot be installed wrongly. Management should also recognize that shift changes, night work and other conditions can increase the chance of errors.

Before things go wrong, maintenance organizations should recognize that the origins of problems may lie as much with the organization as with individual workers. From time to time, it helps to ask questions such as the following: Would work grind to a halt if things were done by the book? Does maintenance quality ever take second place to commercial pressures? Are incidents investigated and publicized within the company? Is there a system in place to allow maintenance personnel to express their concerns? Are workers afraid to admit their mistakes because of a fear of punishment?

After an incident has occurred, it is important for the organization to assess why it happened, without merely looking for *people* to blame. Incident investigations are an excellent opportunity to discover weaknesses in the system.

Training maintenance personnell in human factors and crew resource management can also help to avoid human-related problems. Crew resource management for maintenance has already been successfully introduced by some North American carriers. Participants learn about issues such as stress and work pressures and are taught to communicate clearly and assertively.

Sadly, it sometimes takes an accident or serious incident before there is agreement on what needs to be changed within the organization. It is far better to identify the human factors and organizational failings before they have an opportunity to cause trouble, because reacting to disasters after the event is a costly and inefficient way of improving safety.

Notes

1. *Aircraft Accident Report 92/04, (NTSB), 1992.*
2. *Flight Safety Occurrence Digest, 92/D/12. (UK CAA),9 June 1992.*
3. *Aircraft Accident Report 2-91, (Presidency of Civil Aviation, Kingdom of Saudi Arabia), 1993.*
4. *Aircraft Accident Report 1/92, (UK AAIB), 1992.*
5. *Aircraft Accident Report 79-17, (NTSB).1979.*
6. *Aircraft Accident Report 84/04, (NTSB).1984.*
7. *ibid.*

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Mosquito Crash

On July 21 1996, the last flying Mosquito crashed while displaying at Barton Aerodrome near Manchester with the loss of both crew members.

I was displaying that day in a Lynx Mk 3 and had flown the previous slot, talking to the Mosquito crew on the radio about run-in times and separation etc. We landed after an uneventful and pretty uninspiring show and gave an embarrassed wave to an over generous round of applause from the crowd as the 'Mossy' ran in.

She made a splendid noise as she roared past on her first flyby. However, the bar was open and it was a gloriously sunny day, so we adjourned – besides the beer was northern, creamy and free! I lifted my pint, looked at it in appreciation and raised it to my lips... there was a large crunch and a plume of black smoke rose in the sky.

It took me a couple of seconds to appreciate the enormity of the situation. The Mosquito had crashed about a mile and a half off the end of the runway. Rick Anderson, my landaway buddy for the weekend, broke the stunned silence in the bar by shouting "Johnny! SAR!". We left at the rush and were airborne about 4 minutes later.

I suppose in our mind's eye we would fly through the smoke and the flames and pluck the survivors from the wreckage, perhaps win Air Force Crosses and appear on Esther Rantzen's "Hearts of Gold". That is not how it turned out and this is not the forum to discuss the nitty gritty of exactly what did happen on that very sad and grim afternoon. However, the following points stand out in my mind as being significant and worth a minute's thought.

CHECKS. We did very few in our haste to get airborne. I paused momentarily when Rick shouted "Hold it" as I was about to turn the head (someone was too close to the tail rotor). The AFCS had not had time to wind up and consequently we had a tight downwind takeoff and a challenging landing in a ploughed field very close to power cables, negative 'Stab'. With hindsight we had all the time in the world, but then hindsight is 20/20. What corners will you cut?

FUEL. It was only on the ground at the crash site that I fully realized we had not had time to refuel, on top of which all our FLIPS etc had been unloaded for the display. I had a '1/2 mil' in my leg pocket and that was that. Where was the nearest hospital? And how low would I run the fuel before landing on the hard shoulder of the East Lancs Road. The police helo was airborne at this stage and provided details of the hospital landing site which was only 5 miles away. Again, with hindsight, we would have been better swapping roles with the police – refuelling and waiting in support. As it turned out Sale hospital landing site is now a car park and we flew our sortie, after a refuel, to a school playing field. When you empty an aircraft for an air display, you are not ideally placed for a SAR mission.

P.O.B. While in the field waiting with decreasing hope the question of persons on board arose. By now the volunteer fire crew, as well as our mechanics and an ambulance crew, were searching a blazing wood at some considerable risk to life and limb, and no-one seemed to know how many people were on board. Not only were we putting eight or more people at extra risk; had we rescued a survivor, how long would we have sat looking for another (potentially non existent) before heading off to Casualty? To lose someone in those circumstances would have been a bitter pill to swallow. Eventually the home field was telephoned and the search was stopped.

ALCOHOL. I was lucky (or unlucky depending on your point of view) that I had not yet sipped my drink. Would I have got airborne had I done so? Certainly yes. Would I have flown had I been on pint number six? Certainly not. Somewhere in between a very tough decision would have had to be made. At the subsequent Board of Inquiry... When you are at a small civilian aerodrome with no dedicated SAR helo and something goes horribly wrong, all eyes will look at you, sober or not.

AFTER EFFECTS. The ambulance crews, fire crews and aircrew had a long liquid debrief and turned in, tired and drawn. The next day I carried on to the North Wales Mountain Flying Training Area for two days work up prior to an Antarctic deployment. After half an hour I was completely fed up, my mind was elsewhere and my bottle for the rocky peaks of Snowdonia was well and truly missing. It sounds pathetic as I write it but I was a little weak and emotional about the whole thing for quite a while. Flying bodies is a grisly task. Don't underestimate the effect that it may have on yourself or your crew.

Finally, my closing thought is that when you have your helo keys in your pocket you can be catapulted from a pint of Boddingtons to a major disaster scenario in a matter of seconds. Despite several years of military training and flying I felt unprepared.

Editors Note: A thoughtful article which touches on many interesting issues – the good samaritan complex, pressing, preparedness, and post traumatic stress syndrome. Something to think about the next time you find yourself the only rotary wing asset at a smaller show. ◆

By Lieutenant J Hartley RN
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Leadership and the CF-18 Hornet Pilot

Your twelve ship formation of Hornets is ingressing to the target area at nearly the speed of sound. Inside each one of these aircraft is a fully trained Hornet pilot, many of whom are at least as qualified as you are to lead this formation. Their training and discipline has taught them to follow your briefed plan to the letter. As you proceed, a situation develops that could put the formation in danger. Deteriorating weather has lured your flight lead into VFR flight in poor weather conditions. Every one of your formation members is concerned for the safety of the formation but no one transmits a single word. "Comm discipline" is adhered to. The stage is set for a needless tragic accident.

What is the formation dynamic that led to this situation? How can trained professionals with a desire to "do the right thing" be wowed into silence in the face of something they know to be wrong? At what point must a follower become a leader? The answers to these questions are not simple and indeed are dependent upon a great number of variables. This paper will explore these questions and other considerations in an attempt to offer solutions, or at least provide a starting point for those in the business of formation flying to evaluate their responsibility within the formation. Leadership will be discussed as the concept applies to the Hornet pilot. The lead-wingman balance will be discussed. Conflict will be defined and its effect on the formation will be studied. As well, and probably most importantly, conflict resolution will be offered as taught by the ANG cockpit resource manual.

The CF defines leadership as "the art of influencing people so as to accomplish a mission in the manner desired by the leader". Following basic principles of leadership will provide the formation lead with a good starting point to reduce conflicts within his formation. For instance, a Hornet lead must achieve professional competence. This includes knowing his jet and the threat, and maximizing the effectiveness of his assets, including his wingman. A Hornet lead must also lead by example. He cannot expect his formation members to do that which he is incapable or unwilling to do. He must also make sure that his followers know his meaning and intent, and then lead them to the accomplishment of the mission. A Hornet lead will also develop the leadership potential of his followers. This includes seeking and accepting inputs and addressing wingman concerns in a respectful manner. Another important leadership practice is to make sound and timely decisions. This has very important implications for a formation lead, as often there is no margin for error. If the flight lead fails this, not only are there flight safety implications, but a conflict within the formation will probably result. A good flight lead will train his men as a team and employ them up to their capabilities. He will not expect too much from a junior wingman and will properly challenge a more senior member. Lastly, he will keep his followers informed of the mission and the changing situation within the constraints of tactical comm brevity requirements.

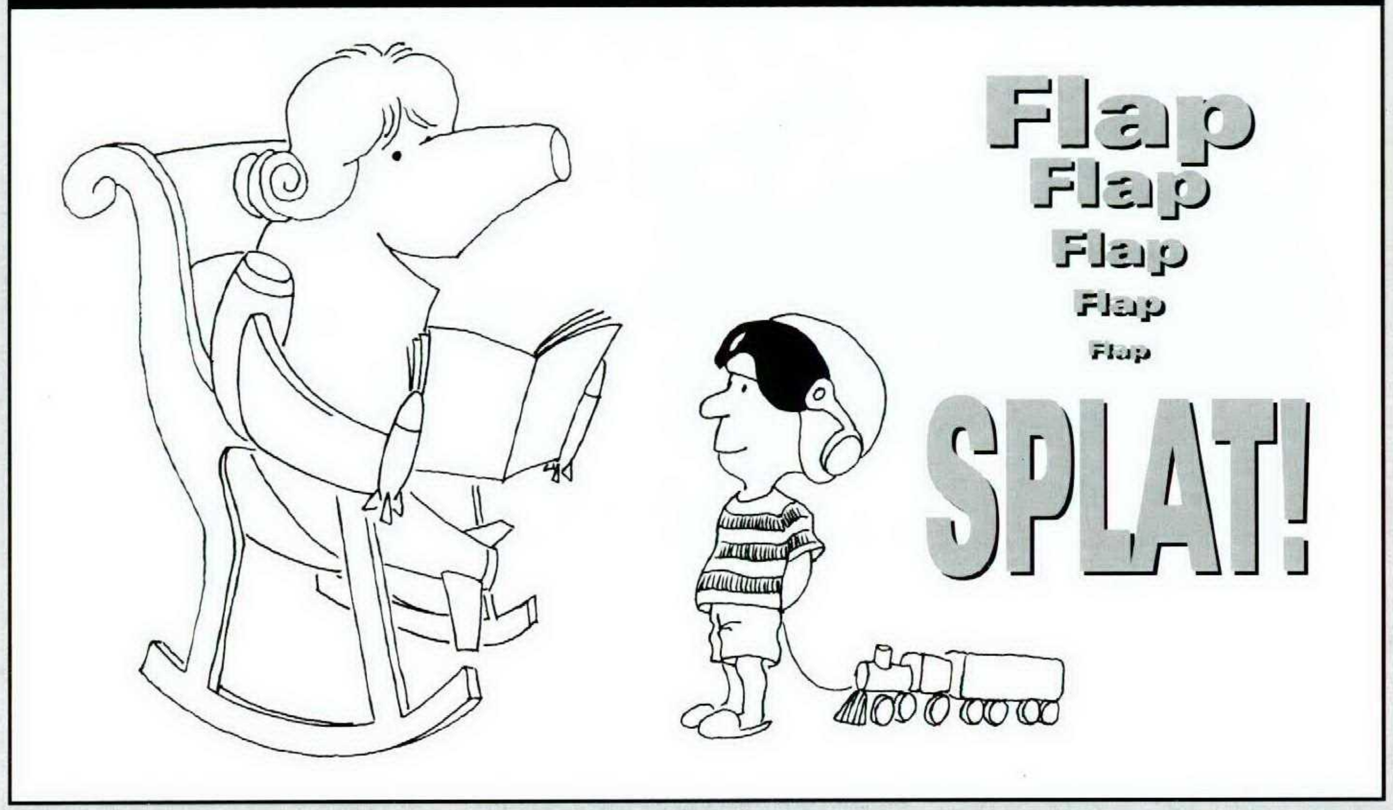
The flight lead should consider his wingman a copilot. But what part does the wingman really play in the accomplishment of the mission? Should he blindly follow like an unthinking automaton? Conversely, should he second guess and question every decision lead makes? Neither choice is a good one, with possible outcomes ranging from reduced mission effectiveness to flight safety problems to complete formation anarchy.

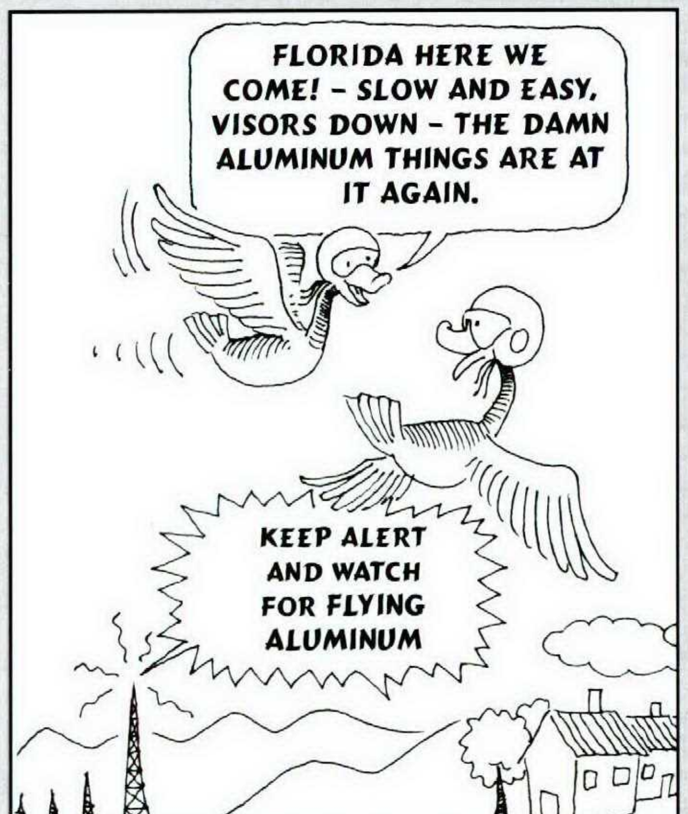
Indeed, a balance must be struck. The wingman must consider his role an important but supportive one. In the brief and debrief, he should offer his

continued on page 31

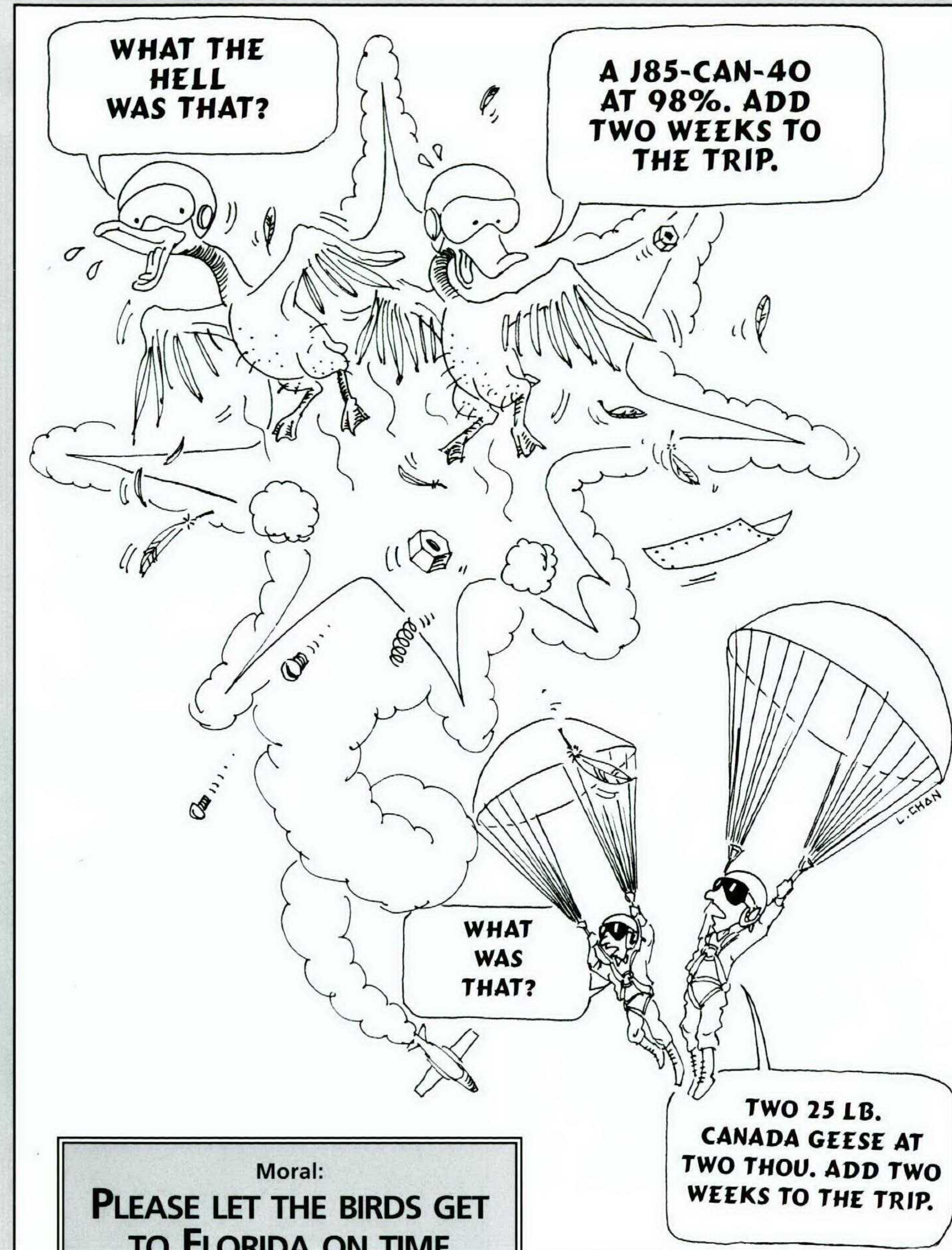
AIRSOP'S FABLE

Everything you always wanted to know about birds*





* They vacation in Florida — if they are lucky.



Moral:

PLEASE LET THE BIRDS GET TO FLORIDA ON TIME

Corporal J.W. Gaetan Boily

Cpl Boily is an Airframe Technician with 8 Air Maintenance Squadron Trenton.

When a CC130 Hercules was reported unserviceable for a malfunctioning outboard leading edge anti-ice system for the second time in two weeks, Cpl Boily began researching CC130 anti-ice system problems. He determined that there were a total of seventeen similar unserviceabilities in the fleet. Further investigation revealed that the problem was restricted to aircraft that had been modified with the new anti-icing valves. Realizing the seriousness of his findings, Cpl Boily compiled all his research and staffed it through his supervisors for action. He also raised a UCR to ensure a quick response to a critical situation. As a result, modification of CC130 aircraft with the new anti-ice valve has been suspended and the operating instructions of the anti-ice system have been modified until the problem is rectified.

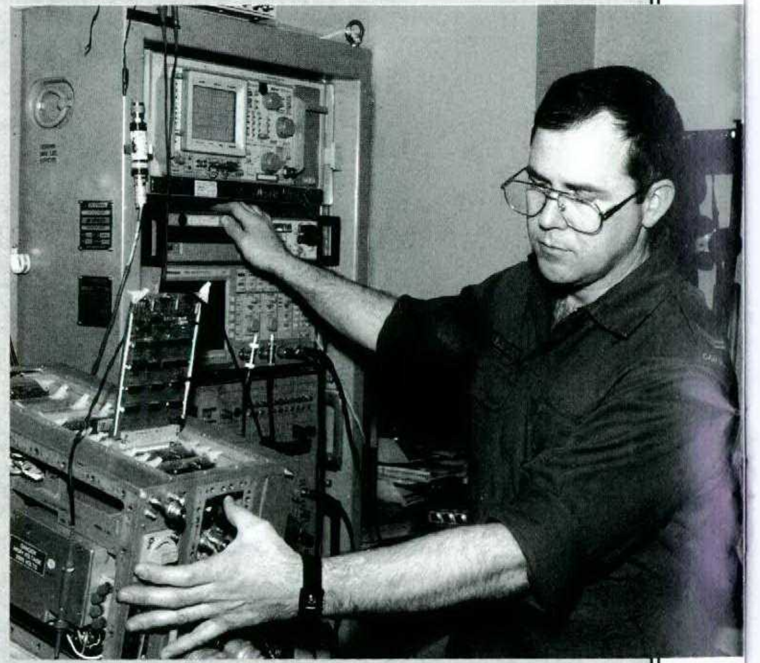
Cpl Boily's professionalism, initiative and dedication were instrumental in identifying problems with the new anti-ice valves and reducing the potential for a serious inflight occurrence. ◆

Corporal Doug Buchanan

Cpl Buchanan, a Communication and Radar Systems Technician with 14 Air Maintenance Squadron Greenwood, was inspecting in the AVS labs shop two Radar Synchronizers, both of which were severely burnt internally, from two different CP140 Aurora.

He recalled a previous unserviceability with the same characteristics which had been caused by crossed aircraft electrical power phase wires. He researched the history of both aircraft and Cpl Buchanan discovered a similar history of electrical problems on one of the two aircraft. As happened in the previous circumstance, the majority of these faults could not be duplicated in the avionics lab. That same day the lab received a Radar Scan Converter from this aircraft with an Input Transformer which had major internal damage. His suspicions reinforced, he advised his supervisor of his concerns and line servicing was notified. He followed up with line servicing until the aircraft was investigated and the power problem was rectified.

Cpl Buchanan's professionalism, dedication and determination averted a potentially hazardous flight safety occurrence. ◆



Master Corporal Nola Leroux

MCpl Leroux, a Safety Systems Technician with 434(CS) Squadron Greenwood, was conducting on the job training with her crew on a newly modified T-33.

On completion of the training she was of the opinion that something was amiss with the ejection seat. It was only after further inspections of the seat and many phone calls that MCpl Leroux was able to ascertain that the ejection seats had not undergone their regular inspections while the aircraft was being modified. Additionally, other CF349 entries and inspections had been deferred during the same period of time thus allowing the aircraft to fly with critical components and aircrew life support equipment well past inspection. Following these discoveries and determined to prevent a reoccurrence MCpl Leroux was also instrumental in having new measures put into place to ensure no future errors.

MCpl Leroux's professionalism, dedication and attention to detail averted a possible serious occurrence or fatal situation. ◆

Corporal Giuseppe Gizzi

Cpl Gizzi, an Air Force Reserve Air Frame Technician with 12 Air Maintenance Squadron Shearwater, was conducting a Before Flight Inspection("B" Check) on a CH124A Sea King.

During his check of the interior of the aircraft, Cpl Gizzi moved a piece of fuselage soundproofing aside for a more detailed inspection of an area not normally verified prior to flight. He noticed an abnormality with the left hand sponson mount fitting which conveys the load of the undercarriage to the airframe. Closer investigation revealed a missing fastener and an undersized bolt installed in the fitting. He then inspected the right hand sponson fitting and also discovered what appeared to be an improper bolt. He immediately informed his supervisors who declared the aircraft unserviceable.

Cpl Gizzi's professionalism, dedication and attention to detail averted a possible failure in the undercarriage and severe damage to the aircraft. ◆

Master Corporal Claude Pothier

MCpl Pothier, a Flight Engineer at 413 Transport and Rescue Squadron Greenwood, was performing a pre-flight inspection on a CH113 Labrador prior to a test flight.

During his inspection he noticed a small puddle of hydraulic fluid under the aircraft. In order to investigate further, MCpl Pothier opened the SAS control closet which is not a normal part of the inspection. He subsequently discovered that a rivet had sheared on the pitch rate limiter and that the movement of its arm had caused severe damage to several components of the flight control system. Had this damage gone unnoticed, serious problems could have developed during the test flight.

MCpl Pothier's professionalism and attention to detail in the performance of his duties prevented the possibility of further damage to the aircraft and the potential for a serious inflight emergency. ◆

Master Corporal Marc Lariviere

MCpl Lariviere, an Aero Engine Technician at 434(CS) Squadron Greenwood, was conducting a visual inspection of the left hand engine throttle quadrant linkage of a CC144 Challenger during a periodic maintenance inspection.

After completing his inspection and although not part of the inspection card, he further checked the associated hardware connections on the throttle handle. He discovered that the cotter pin, which ensures that the throttle and linkage do not separate, was missing. Further investigation by MCpl Lariviere revealed that the cotter pin in the right hand throttle handle was also missing. He immediately informed his supervisor of his findings and as a result a fleet wide Special Inspection(SI) was initiated. Had this problem gone unnoticed the fastener and nut holding the linkage in place could have vibrated loose resulting in the probable loss of engine control.

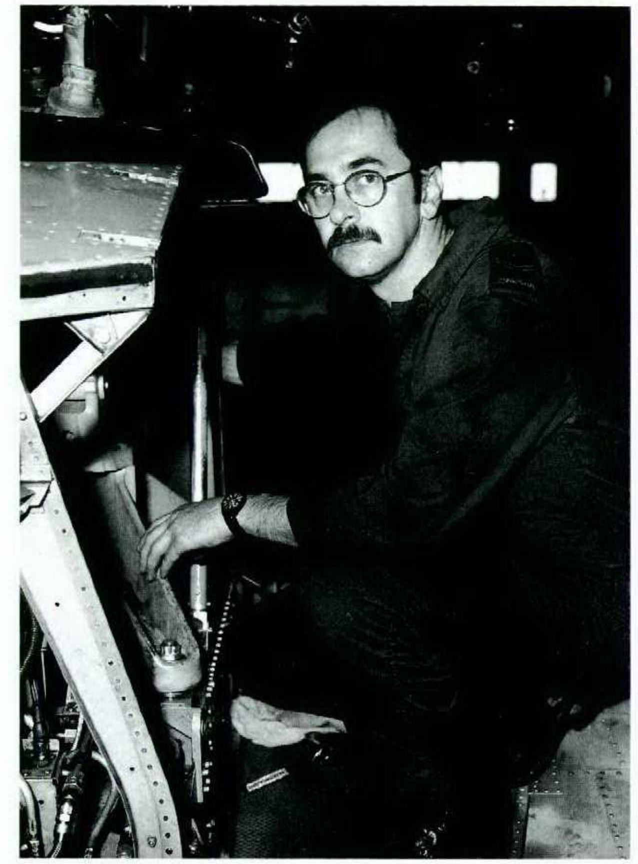
MCpl Lariviere's professionalism, diligence and attention to detail averted a possible serious inflight occurrence. ◆

Corporal Kit Croteau

Cpl Croteau, an Aviation Technician with 438 Tactical Helicopter Squadron Montreal, was assigned to work on a CH146 Griffon which, for the second time, had a chip detection light illuminate on the number one engine.

Having inspected the chip detector and once again finding no evidence of metal particles, Cpl Croteau was tasked to troubleshoot the electrical system for the warning lights. During his inspection he noticed that one of the two shutoff valves was leaking oil and he became concerned the valve may be damaged. He requested the night crew to change the valve. When the valve was checked serviceable, he was asked to sign as the aircraft being serviceable. Not convinced the problem was rectified, Cpl Croteau checked to see if the leak might be caused by an obstruction preventing the valve from closing. He discovered a piece of metal blocking the valve and upon further investigation discovered another metal fragment at the bottom of the gearbox. The metal fragments were from a ring that retains the engine transmission shaft to the gearbox.

Cpl Croteau's professionalism, determination and persistence likely prevented a serious flight safety occurrence. ◆



Corporal Yves J.G. Desfosses

Cpl Desfosses, an Airframe Technician with 442 (Transport and Rescue) Squadron was tasked to conduct a post period quality assurance audit on a CH113 Labrador.

During the inspection, which continued several hours past the end of his shift, Cpl Desfosses discovered an incorrectly installed beveled washer in an extremely inaccessible area that was not part of the Airframe QA checklist. Further investigation by Cpl Desfosses revealed that the correct installation of this particular washer was not defined in technical orders. If this incorrect installation had gone undetected , full left deflection of the flight controls could cause the washer to jam, shearing the forward swash plate drive scissors resulting in the loss of aircraft control. As a result a UCR was raised against the CFTOs and a fleet wide Special Inspection(SI) was implemented.

Cpl Desfosses's professionalism, dedication and attention to detail averted a potentially serious flight safety occurrence. ◆

For Professionalism

Corporal Vinny O'Reilly

Cpl O'Reilly, an Aviation Technician with 434(CS) Squadron Greenwood, received a post-flight debrief by the aircraft captain of a T-33 concerning a flight control problem immediately after takeoff.

The incoming snag crew was briefed by Cpl O'Reilly at which time he explained that there was a possible rigging problem in the right hand wing. The next day he reviewed the snag rectification sheet and noted the problem had been identified as a fuel feed problem. As the problem had been noted by the pilot immediately after takeoff, Cpl O'Reilly was concerned that the snag crew's rectification did not take into account all phases of flight. Noting that a test flight was scheduled for that day, Cpl O'Reilly advised his supervisor of his concerns thus raising some questions of the snag being a fuel feed problem. The test flight was delayed and further investigation revealed that the ailerons were out of rigging by 100lbs tension.

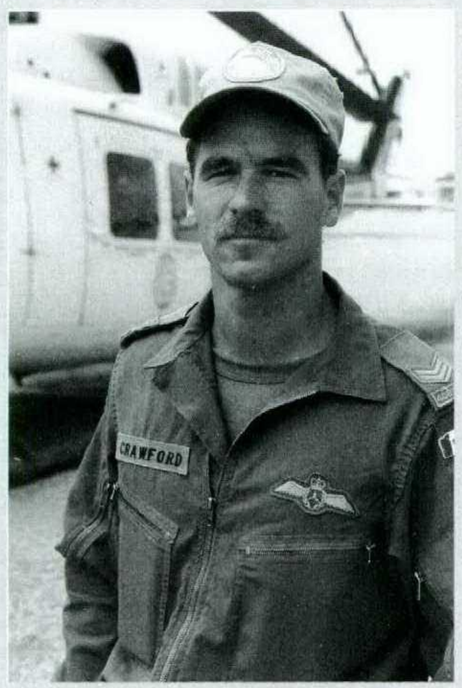
Cpl O'Reilly's professionalism, perseverance and dedication prevented a flight test being carried out with a serious flight control problem which could have resulted in the loss of both aircraft and crew. ◆

Corporal Rob Crawford

Cpl Crawford, a Flight Engineer from 408 Tactical Helicopter Squadron Edmonton with the Canadian Contingent in Haiti, was conducting a preflight inspection of a CH135 Twin Huey.

During the inspection he noticed an oil/grease residue around the attachment screws for a removable structural panel on the left side of the pilon. Although the preflight check does not require an inspection of this area, Cpl Crawford removed the panel and noticed that the tail rotor output quill coupling showed signs of grease leakage and an overheat condition. He immediately informed maintenance personnel who proceeded to remove the coupling. A detailed inspection of the coupling revealed the loss of lubrication was caused by a worn seal. Had this condition gone unnoticed the coupling most likely would have failed prior to the next periodic inspection which was due in approximately 100 hours.

Cpl Crawford's professionalism, diligence and astute observation prevented a possible serious flight control problem which could have endangered both aircraft and crew. ◆



Leadership and the CF-18 Hornet Pilot *continued from page 3*

perspective and advice when requested and address Flight Safety and critical tactical concerns at his discretion. Any technique oriented questions or comments should be reserved for after the debrief in an informal discussion. Once airborne, the wingman does not have the option to query every concern he has. Unfortunately, conflicts occur and a system must be in place for formation members to resolve them while taking tactical brevity into consideration.

According to The Air National Guard Cockpit Resource Manual conflict occurs "when what you expect to happen, for mission effectiveness or safety, is different than what is actually happening". If this situation occurs the wingman must decide if the problem requires a comm interchange.

To decide, the wingman must ask the question "is safety involved?" This could include flight safety or tactical safety. Flight safety includes any generic or domestic situation that could put the formation in danger. Tactical safety is any situation that will introduce the formation to undue risk from any type of threat. If the answer to the safety question is yes, the wingman must make his concerns known. Otherwise, most situations can wait for the debrief.

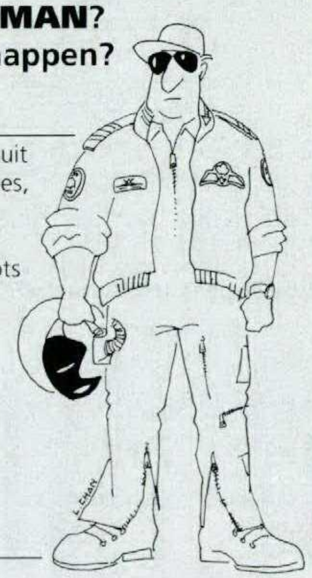
Once the formation member decides there is a conflict that must be resolved there are several methods of resolution. The classic "I have the lead" only rarely works and should be used only as a last resort. Another more tactful method of conflict management is taught by the ANG and includes eight steps. First, the issue must be defined. In other words, what is expected to happen and what is happening must be compared. Then, the evidence must be determined. This means gathering as much data about the situation as possible. Make an "I" statement to indicate a concern. For instance, "Black lead, I'm below MSA in IMC conditions without a clearance." Next, state the problem. "Black Lead, we're too low." Then a solution must be proposed, in "We" language. "Black Lead, we should climb." Now comes the hard part stop talking and listen. Abandon your idea if required. Lastly, be assertive if required, in direct proportion to the severity of the situation. These steps should alleviate the problems being encountered within the formation.

In the fast moving arena of formation flying, there is little room for error. Every member must be counted upon to do his job, or the entire formation will endure the consequences. When a situation arises that could put the formation in danger, action must be taken. It remains each members responsibility to carry out the appropriate action so that the formation can carry out its mission objectives and live to fight again. ◆

anonymous

ACCIDENT MAN

WHAT SORT OF MAN – OR WOMEN is ACCIDENT MAN?
Check your rating. Are you an accident waiting to happen?



MEDICAL

ACCIDENT MAN will almost certainly be overdue for his medical or, he won't have completed the full procedure. He'll still need a blood test or a visit to the fang farrier, or his inoculations.

LOGBOOK

ACCIDENT MAN thinks administration is for lesser mortals; his logbook is updated yearly. Besides it's none of HQ's business how much he flies. Check his pubs bag – it's not his fault that the printers didn't send enough – besides nothing ever changes in them anyway. He NEVER signs his quarterlies.

SAFETY SYSTEMS

ACCIDENT MAN thinks dingy drill is for wimps; he gets more water time on his jet-ski. Simulator time is so dull. What can you learn from a box strapped to the ground. Hauling that LPSV up for an inspection is such a pain; he'll never need all that stuff anyway – whatever is in the thing.

IMAGE

LOTS of badges on the flying suit (size IS important), mirror shades, any kind T-shirt as long as it doesn't remotely resemble a turtleneck. Polish repelling boots help him keep that IR profile down as does the bill on the "Good old Boys" ball cap. **ACCIDENT MAN** also makes sure that his kit has that lived in look – doesn't want to be mistaken for some new guy.

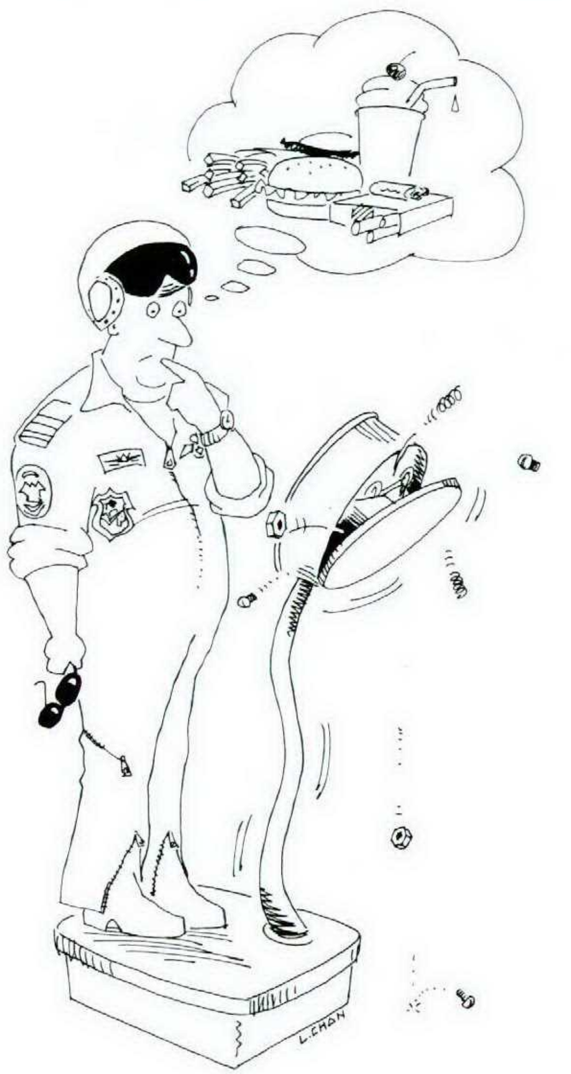
BEER BELLY

ACCIDENT MAN approves of exercise – for others; all the easier to be a pole-hog when the other guy is at the MIR. Anyway you don't have to be fit to fly – he knows that a bit of a gut gives you extra G tolerance.

Idea Courtesy of Strike Safe Issue 52

AIRCREW WEIGHT and Ejection Seats

(OR WHY THE ELASTICATED WAISTBAND IS NOT THE ANSWER)



Most of us over the age of 21 have experienced the mess kit which shrinks when left in the wardrobe over a period of time, and the added mystery of the increasing waistline even though "we don't eat a thing". No, this is not another boring old homily from one of those annoying medics who take the joy out of life, but a little chat about what beer and chips can mean to aircrew.

Even if you have not been exposed to the posters on the crewroom wall which exhort you to "know your weight", you will have been aware that there is something going on about aircrew weight, particularly for those of you sitting on ejection seats. Well, what does a few extra pounds of "it's all muscle" mean when compared to tons of hard metal, I hear you ask. Nothing really, until the time comes when you want to leave the cockpit on one of Martin Baker's best – then that few extra *pounds* can mean a lot. (The lack of enough pounds can also mean a lot, but that is the topic of another little chat).

When all those tons of metal were a gleam in the designer's eye, the ejection seat manufacturer was given a set of numbers around which to design the escape system. One of these sets of numbers was the size of aircrew likely to be sitting in the aircraft and another set was a guess at the amount of clothing and equipment likely to be worn. But this was all so long ago, 1970 in fact, and we have had a suspicion that not only are today's aircrew on the whole heavier, but that the aircrew equipment is also heavier than it was 30 years ago. So all of you have had your weights collated from your annual medicals and this has been compared to your weights when you joined up. We have only been able to look at the statistics for Tornado aircrew to date, the rest of you are due later this year, but it would be a little unwise to think that there will be much difference for aircrew flying other aircraft types. A look at the 2 graphs below shows at a glance that a lot of you are heavier than your counterparts in the 1970s and also that you tend to gain quite a bit in weight over the years – up to 16 Kg (35 lbs) over 15-20 years.

But, worse is to come. The ejection seats you are sitting on were qualified for a certain parachute borne mass. This is you, your equipment, parachute harness, PSP and the ejected part of the seat. All this equipment weighs a lot more now than it did in the design stage, and to make matters a little more complicated still, the ejection seats in some aircraft have had bits and pieces added, and this extra weight means less weight available for aircrew and equipment. In Tornado, the ejected part of the seat now weighs 102 Kg instead of 97.5 Kg. The old body weight limits were derived simply by taking the weights of all the hardware away from the qualified seat mass, leaving the "nude body mass". If you are at the upper limits of the nude body mass wearing summer AEA, then with winter/sea and winter/sea/NBC AEA you can be well above the qualified mass limits of the seat. And that is without all those essential items you carry in your pockets, and have we seen some weighty collections there!

Well, what does all this mean to me, I hear you say. Just this; the reason you sit on an ejection seat is that one day you may want to leave the aircraft before it has come to its customary stop near the hangar, and when this time comes, you will want to do this in such a way that you do not become an attachment to the empennage and also, if you leave the aircraft close to the ground, ideally you want enough time for your parachute to lower you gently earthwards. It is obvious that the heavier you are the more push you are going to need from the ejection seat gun to get you the right height above the aircraft, but there is a limit to the amount of push that can be delivered and keep you safe and well. Apart from Tornado, which requires a little bit extra to get you over the large fin, the charges in the guns have been downrated to minimize injury. In other words, the ejection seats have been engineered to get you out of a wide range of difficult situations without causing excessive injury, and any increase in gun velocity to push the bigger aircrew out will have a big increase in injury for all, and this is unacceptable.

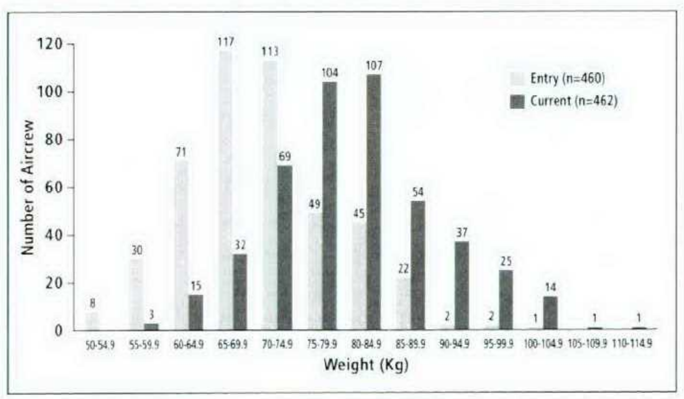
Well, if we are all heavier than our ancestors, what can we do. In the first instance, we can move away from just thinking about nude body weight and realize that the final limiter is the weight we are when we walk out to the aircraft wearing all the AEA and equipment for the day. Calculations have been carried out to try to determine what the effect of increased boarding weight would have on the ejection envelope, and these have indicated that ejection can be safe if the aircraft is not too low and not too slow. Provided you keep at least 30 kts of airspeed you will get out of the aircraft and gain enough altitudes to deploy the main parachute canopy. You might have a heavier than usual landing with the risk of a leg injury with the present parachutes, but a poorly leg is better than the alternative. So, the reaction time to an emergency needs to be that little bit faster and any natural delay to eject minimized for those of you over the limit.

Work is in hand to modify the ejection seats and parachutes to try to extend the weight limits, but in the mean time, why not try a little of the diet and exercise – think of the saving on tailor's bills. ◆

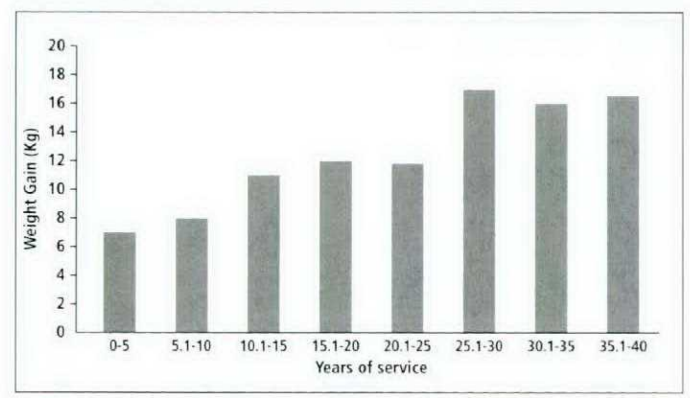
By Wg Cdr Jenny Cugley, RAF School of Aviation Medicine

Reprinted Courtesy RAF Strike Safe Issue 55

Entry Weight and Current Weight of Tornado Aircrew



Mean Weight Gained Over the Number of Years Served in RAF



NO FOOLIN'... PART DEUX

REF: Flight Comment 2/1996 pg 11

Prior to entering the control zone a call for clearance was mistakenly made on Squadron Operations (Sqn Ops) Frequency. Aircrew at the Squadron cleared the aircraft into the control zone as a "prank". Upon reaching a designated reporting point another call was made on Squadron frequency and Operations attempted to clear the aircraft to the ramp. The Aircrew realized that they were transmitting on the wrong frequency on short final.

During the follow up to this occurrence the aircrew in Sqn Ops believed that the aircraft crew where aware they were transmitting on the wrong frequency but made no attempt to inform the aircraft crew of such. Traffic on the airfield at the time was moderate and the aircraft crossed the approach end of the active runway.

A similar occurrence was reported in the reference issue involving basically the same "prank". Fortunately loss or damage of resources was none. The following is a repeat of the message in Flight Comment 2/1996.

REMEMBER: The potential for a serious mishap from this seemingly insignificant "prank" could have been severe. ◆

DFS CONTACTS

EMERGENCY: IN THE EVENT OF AN AIRCRAFT ACCIDENT OR A SAFETY CONCERN WHICH REQUIRES IMMEDIATE ATTENTION

PHONE 1-888-927-6337 • 1-888-WARN-DFS 24 HOURS a day

A qualified Flight Safety Officer will answer your call

FOR NORMAL BUSINESS:

Telephone

Col M. Legault (DFS)
AVN 842-1118 or (613) 992-1118
Pager (613) 786-6120

LCol Gagnon (DFS 2)
AVN 842-1880 or (613) 992-1880
Pager (613) 786-6139

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DFS 2-2-2 Maj Hayter
AVN 842-0140 or (613) 992-0140

DFS 2-3 Maj McCarthy
AVN 845-6551 or (613) 995-6551

DFS 2-3-2 Maj Harrod
AVN 845-5520 or (613) 995-5520

DFS 2-4 Maj MacDonald
AVN 842-0149 or (613) 992-0149

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AVN 845-2654 or (613) 995-2654

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DFS 3-3 Capt Medves
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DFS 3-4 Ms Bull
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FAX

AVN 842-5187 or (613) 992-5187

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Nº DE TÉL. 1-888-927-6337 • 1-888-WARN-DFS 24 HEURES par jour,

un officier de la sécurité aérienne qualifié répondra à votre appel

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DSV - ENQUÊTES SUR LES ACCIDENTS ET OFFICIERS DE SERVICE :

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