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SUMMER 1998

Flight Comment

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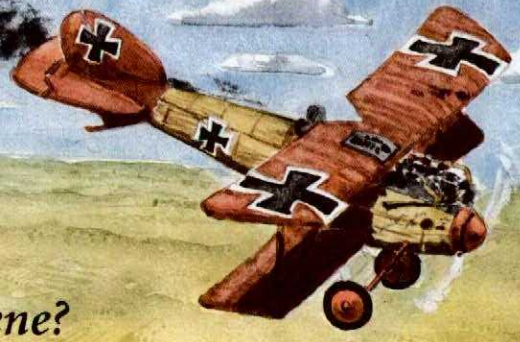

Canada

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Bar to Distinguished Service Order

Collishaw D.S.O., O.B.E., D.S.C., D.F.C., Raymond Lt. (T.Maj.) RAF 21 Sept 1918

A brilliant squadron leader of exceptional daring, who has destroyed 51 enemy machines. Early one morning he, with another pilot, attacked an enemy aerodrome. Seeing three machines brought out of a burning hangar he dived five times, firing bursts at these from a very low altitude, and dropping bombs on the living quarters. He then saw an enemy aeroplane descending over the aerodrome; he attacked it and drove it down in flames. Later, when returning from a reconnaissance of the damaged hangars, he was attacked by three Albatross scouts, who pursued him to our lines, when he turned and attacked one, which fell out of control and crashed. ◆

On the Cover

Sopwith triplane N 5492 "Black Maria" of No 10 Squadron RNAS piloted by Flight Commander Raymond Collishaw on 27 June 1917. On this date Flight Commander Collishaw shot down and killed Lieutenant Karl Allmenroder, a thirty victory ace of Jasta 11.

Other B Flight triplanes and Canadian pilots, were:
Flight Sub-Lieutenant Nash in N 5376 "Black Sheep"
Flight Sub-Lieutenant Ried in N 5483 "Black Roger"
Flight Sub-Lieutenant Alexander in N 5487 "Black Prince"
Flight Sub-Lieutenant Sharman in N 6307 "Black Death"

Raymond Collishaw was arguably the greatest air leader Canada has ever produced. He was the most successful fighter pilot of the Royal Naval Air Service and his inspired leadership made the "Black" Flight of No. 10 Squadron RNAS one of the most admired and feared units on the Western front. Raymond Collishaw later saw service in Russia during the Bolshevik revolution and in North Africa during World War Two. He reached the rank of Air Vice-Marshal and was made a Companion of the Order of the Bath. Additionally he received the Distinguished Service Order twice, the Distinguished Service Cross, the Distinguished Flying Cross, as well as both military and civil grades of the Order of the British Empire. The citation for his Bar to the Distinguished Service Order is printed above.

Painting by Mr. Roy Ahopelto

Flight Comment

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From the Editor

I have been attempting to ascribe a theme to each issue of Flight Comment. Hopefully the linkage amongst the lead articles will generate discussion and perhaps encourage you to do further reading. The theme of this issue is communication.

For people that live in the so-called information age we do a very poor job of communicating. Perhaps some of our communication problems are simply the result of having to try to process the huge amount of information we are exposed to each and every day. Although I tend to believe that while we have become experts in sending the message, we still remain sadly lacking in listening abilities. Fog Horn Leghorn is alive and well.

The article "Countdown to Disaster" relates a tragic scenario where lack of communication leads to a mid-air collision. Could something similar happen here? You betcha. If you can read this article and don't find yourself shaking your head and thinking back to some "what are we doing here?" mission you are either very lucky or blissfully unaware.

You are on fire! A simple statement you would think would be hard to misconstrue. But what happens when the communication it is not addressed correctly? A debacle – and all the result of imprecise communication.

Communicating with outside agencies are not the only problems we encounter. Have you ever been on the flight deck when everyone is talking, but no one is listening? Or the self-induced sterile cockpit where no one is talking or listening? Scary stuff. The article "To intervene or not to intervene? The copilot's Catch-22" offers excellent advise on how critical information should be communicated on the flight deck and the article "Both starboard engines have gone!" shows a first-rate practical demonstration of communicative skills in truly trying circumstances.

Lastly there is non-verbal communication. We send non-verbal communication all the time (children are masters of the form). The technician who didn't pull the chocks on the Hercules was really telling the aircrew "regardless of what you want to do, I am not going to let you kill yourselves." I don't think he could have found a more effective way to communicate his message. In this case someone was listening.

We do tend to listen better when the message is one we want to hear. One message I received at the flight safety conference was to pluck the DFS safety bird. As I have never been a fan of our avian mascot I am more than happy to listen. Buzz B. Safe has gone to the big roost in the sky.

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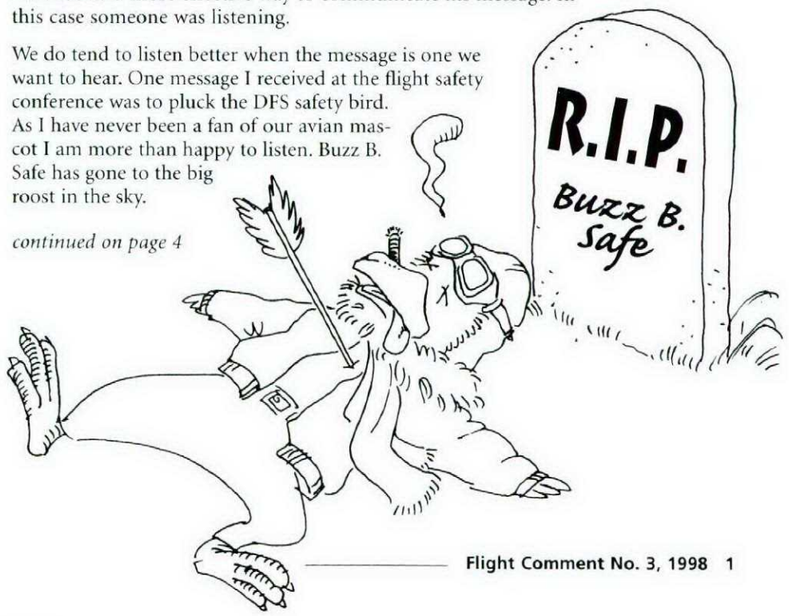

Countdown To Disaster

What was the chain of events that led 18 soldiers to their deaths on June 12 last year, in Australia's worst military disaster since the Voyager collision?

IT was an odd way to plan a counterterrorist exercise. Upstairs in the Townsville army building, Special Air Service Regiment soldiers gathered in private to plan the next day's mission, a rescue of "hostages" involving six helicopters and live ammunition. Downstairs, apparently excluded in the name of security, the air crews who would have to fly the SAS counterterrorist troops to the target held their own meeting.

Every so often, whenever combined planning was called for, officers from both units took to the stairs. It was the evening of June 11, 1996, and the first day of Day Rotor 96, a biannual exercise designed to maintain the SAS's capabilities for a helicopter-borne counterterrorist strike.

"This was the first occasion on which detailed combined planning took place," noted the Black Hawk board of inquiry report released this week. "Albeit, much of it was not face-to-face."

The inquiry tried to piece together the key factors that led to the deaths of 18 soldiers when two Black Hawk helicopters collided at about 6.45pm on June 12, the day following those initial, separate meetings.

Seven soldiers, their names deleted from the public report, were held accountable by the inquiry. Five will face action, three of them disciplinary (but not criminal) charges that carry possible jail terms.

Yet the report does not appear to seek scapegoats. It argues there were 16 separate primary links in a chain of events that made the disaster inevitable. Twenty-six other contributing factors, including the serious erosion of aviation skills due to unserviceable helicopters and inadequate pay and conditions, are also listed.

So the blame is spread widely and over a time frame of several years. But it was on June 11 that the most immediate problems began to emerge and the upstairs-downstairs planning that evening is cited as one of the contributing factors in the disaster.

Most of the contact that evening occurred between Captain Sean Bellis from the SAS and Captain Kelvin Hales of 5th Aviation regiment, a relatively inexperienced officer who would lead the flight. The pair were already familiar – Hales had been copilot to Bellis, himself a former army Black Hawk helicopter pilot, in previous exercises.

The mission of June 12 was to rescue hostages taken by "terrorists". Two runs were planned – one in daylight and one at night. According to the board, it was probably that evening, up or down the stairs, that Hales learned the SAS would like the Black Hawks to assault in a formation that put three lead helicopters line abreast – that is, next to each other and separated by no less than two rotor-widths.

Hales, a relatively inexperienced pilot and new to the position of "flight lead", apparently agreed to this proposal. It turned out to be a very bad idea.

The Perth-based SAS keeps its counter-terrorism squadron on a high stage of readiness. But the helicopter crews at Townsville are also required for other army tasks and had trained for Day Rotor only a few weeks before. The three-abreast formation was not practised.

This formation, especially when crews' vision is restricted by night-vision goggles (which reduce field of vision to about one-fifth of normal) is inherently risky, according to the board. The chances of something going wrong under pressure are considerable, especially when the middle aircraft has no room to manoeuvre out of trouble.

At 10am on June 12, all the air crew and SAS troops gathered for the day's briefing. The plan was that four groups of SAS troops would rappel on ropes from the hovering Black Hawks and attack the terrorists, using live ammunition. They would be backed by SAS snipers in two other helicopters and mortar support.

The target area was Fire Support Base Barbara, a gun emplacement in the army's High Range training area southwest of Townsville.

No aerial maps were provided at the briefing. No reconnaissance had been done by the pilots. The only map was one drawn by the SAS, mainly to guide the ground assault troops. It was put up on a whiteboard and it was wrong – it depicted a nonexistent gun emplacement to the northwest of the point where, Hales's helicopter, Black One, was to drop its troops.

Despite the lack of accurate maps, the daylight operation went ahead smoothly and Black One, the lead aircraft, off-loaded its troops without a problem.

Later the SAS and the aviators discussed the operation again, separately. The SAS wanted important changes: that the two helicopters providing fire support be released from the formation early, and that the sound and visibility of all the Black Hawks be reduced.

At the meeting of air crew, the pilot of Black Two, Captain David Burke, suggested to Hales that he had dropped his troops at the wrong point. Hales disagreed, but the pair apparently resolved the issue by agreeing they would both go to exactly the same points in the night mission. Hales also suggested they fly a new route, up a valley, to mask the aircraft's approach. Hales's superior, Major Christopher Jameson, says he responded: "Get f ... ed. That's crazy mate, it would take a month to practise. We'll do it exactly as we did this afternoon."

But they didn't: the flight was lower and slightly, but crucially, off the path taken by day. The six Black Hawks took off at about 6.30pm. There was no moon, little wind and the remains of the sunset glowed on the horizon. The crews wore night-vision goggles. At a point about 11 km from the target, a three minute call was given. The helicopters began "contour flight", dipping and rising over the ridges and valleys at about 100 knots.

The route was north towards the target, with the plan that the three leading Black Hawk. came in abreast. Unusually for a flight leader Black One was on the left of the three instead of the middle, a position that made right-hand turns more problematic. It was at about this point the formation began to go off to the left of the route it had used during the day. Most of the pilots noticed, but no one told Hales.

The next call was the 30 second call. It was the signal for the two Black Hawks with snipers to move off. But the call may have confused the crews because it was made at least a minute before the target would be reached.

Crew looking for the target at the 30 second call would have been unable to see anything yet – triggering, according to expert witnesses, anxiety.

Inside the helicopters the SAS troopers got ready to rope down. Black One, flown by Hales, Black Two, flown by Burke, and Black Three moved breast of each other in order to drop their troops a line. No move had yet been made to correct the flight path. Black One made the first of three moves to the right at about the 30second call, followed by a second shortly after.

Black One's right-hand loadmaster saw this meant they were heading for Black Two. He called Hales back left while, on Black Two, Burke was told by his left-hand loadmaster: "He's turning right come right." But Black Two's right-hand loadmaster saw the danger of hitting Black Three: "We can't move right." The formation was still off track.

The target was difficult to see, not only because it as flat on the ground but because the sunset afterglow meant the target area was in shadow and not visible with the night goggles.

This was another straw for the camel's back. The board speculates that the fact the aircraft were off track and that the crew could not yet see the targets meant loadmasters who ought to have been ensuring the helicopters were properly separated had their attention diverted.

A few hundred metres from the target, the gun positions that defined the drop zones emerged from the gloom and a third right turn was made by Black One. (At least, that is according to the board, which discounted evidence from the pilot of Black Four, immediately behind, who believed Black Two turned left into Black One.)

The evidence suggests this fatal last turn by Black One was due to Hales's confusion about where he was to drop his troops. He had approached from a different direction than during the day. In these circumstances, the board believed, he might have needed to rely on his mental image of the inaccurate whiteboard map.

"It seems likely that Captain Hales, convinced this was not the gun emplacement of his rig point, turned right and tracked towards the rig point of Black Two," the board found.

One of Burke's crew in Black Two shouted at him to move up. Burke didn't know whether Black three was still beside him – it was not – so didn't that way. Burke was trying to climb when Hales sought to avoid a collision with a left-bank that brought Black One's rotors smashing into the tail of the other helicopter.

Each of the four rotors struck once and a fifth strike seems likely, according to the evidence of engineers who examined the wreckage. The first passed through the fuel tank, the other three struck the engine.

Black One was quickly doomed. Fuel from Black Two was sucked over its engines, resulting in a midair explosion and fire. It rolled over and , at a force 50 times that of gravity, the aircraft plummeted upside down and exploded on impact, Eleven men died. Hales was among them. Incredibly, two soldiers survived an SAS trooper and a loadmaster.

On board Black Two, Burke said something like: "I'm sorry guys, we're dead." "Don't f ... ing give up on us now," his left-hand loadmaster, Sergeant Bill Mark, said or thought. Burke didn't.

With the tail section in tatters, the helicopter began to rotate clockwise and was airborne for a further five to 10 seconds. Burke wanted to keep it upright because the Black Hawk was designed with substantial crash safety features.

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As I See It!

In these early days of my tenure as Chief of the Air Staff, I am pleased to have the opportunity to write an As I See It column for our Flight Comment magazine. The editor has informed me the theme of this issue is effective communication. There is more than a little serendipity at work here, as I believe that productive and successful communication is the keystone of any safety programme.

Our flight safety programme emphasizes open and honest occurrence reporting and the dissemination of that information as its primary preventive tool. Factual, timely, and frank communication, coupled with the conscientious efforts of all our personnel, contributed to our lowest ever accident rate in 1997. I am always filled with pride when I read the citations of the recipients of Good Show and For Professionalism awards. The outstanding efforts of our personnel are clearly communicated, yet barriers to successful communication remain. Those barriers can include imprecise language, unwarranted or non-existent emphasis, personal or corporate agendas, incomplete or inaccurate information, inappropriate tone, and lack of understanding. While much of our daily communication is innocuous, critical flight safety information must be transmitted in a clear and timely matter. The P.A.C.E. model, explained further in this issue, is an excellent example. Should you find yourself in a situation that requires an emergency warning, don't hesitate to give it – you often have only one 'silver bullet' to shoot and you had better use it at the right time. Conversely, in non-time-critical situations, excessive and inappropriate emphasis can cause a loss of credibility and result in a really critical message being ignored. To properly communicate your safety message it must be delivered at the correct time, in the correct form and in the correct medium.

My message to you about safety is simple – nothing is more important than safety in a peacetime environment. Nothing! How can the primacy of safety be reconciled with the goal of successful mission accomplishment? Easily. While our aim is to "do the job", the job cannot be done when our personnel are injured or killed and our equipment is damaged or destroyed.

I see the air force as a proud team that accomplishes its missions professionally. Strong individual leadership at all levels will foster safe, gratifying and productive careers for our people. To achieve these goals, I require your total and honest commitment to our safety programme. As I see it. ◆

Lieutenant-General D.N. Kinsman
Chief of the Air Staff

From the Editor *continued from page 1*

I hope you enjoy the cover painting of the Sopwith triplane. There is a tendency for people to think of Great War aircraft as being structurally weak; nothing could be farther from the truth. Sir Vernon Brown is quoted from "The fighting Triplanes" by Evan Hadingham.

'One of the things we did not understand was that as the aircraft got faster and faster, so we experienced some rather extraordinary effects. If we flew fast and then did a tight turn, or, for instance, dived an aircraft and then pulled it over in too tight a loop, a sort of haziness crept up over one's eyes, rather like a mist: and there were occasions if you held the tight turn for too long where you almost passed out altogether. In order to find out what was happening Lt Jones asked me to fly at as high a speed as possible over a hut in which was a camera obscura, projecting an image on to a table. As the aeroplane, Sopwith N 5430, flew over the top its image was shown through the lens on to the paper, and, by means of a metronome, he was able to point it every second as I made circles. Afterwards it was a simple calculation to find out what "g" had been applied…

'Lt Jones found by repeated experiment that I could hold 4.5 g for 10 seconds, and that I could hold 6 g for 4-5 seconds. ◆

De-Deicing

Capt John T. Park C130 Pilot Yokota AB, Japan

We all got out and started looking at the aircraft we had just thoroughly deiced. It looked like a big bundt cake with whitish icing poured all over it, streaks running down the sides. Icicles hung off props and wingtips. Wow!

This story took place in November 1994. It represents the challenges and inherent risks that military and civilian aviation must face when dealing with deicing aircraft. In recent years, aircraft mishaps, both minor and major, have made the aviation community hopefully more vigilant about deicing procedures and operations in winter precipitation. As parts of the United States achieve record snowfalls this year, a story about my own first winter weather operation comes to mind.

I was a copilot stationed at Yokota AB, Japan, and this particular mission was flown into Misawa AB about 13 hours into our crew duty day. Unlike Yokota, Misawa is blessed with snow and ice much earlier in the year. On this particular day, our first two stops were in fair weather, but Misawa reported low visibility due to blowing snow and snow showers. This was its first major snow fall of the season.

Our crew rechecked the weather immediately before taking off and once again en route. The snow was still coming down, but the visibility had improved to about 1.5 nm.

The landing was like something out of a simulator mission. We broke out of the weather on the ILS about 1,500 AGL and had clear visibility below the clouds, but everything was white. I had to crosscheck that I was on the localizer course… the runway should be straight ahead. About 2 miles out, we picked up the "rabbit" and looked the outline of the runway lights. We had apparently made our approach between snow showers. The next one was at the west end of the field and headed our way This was my first landing on about 4 inches of newfallen snow. As advertised, the snow was blowing around quite a bit as the C130 slowed below 50 knots in full reverse power. An uneventful, yet memorable landing!

Upon engine shutdown, the snow started a heavy fall again. After unloading and loading cargo for 2 hours, the snow had accumulated quite a bit on the top of the Herc. The engineer called for a deice truck. And this is where it gets real interesting. He did an excellent job of direct to ing the transient alert (TA) personnel on thoroughly deicing the aircraft. The problem was not where they were spraying the plane, but with what.

As mentioned earlier, this was the first major snowfall for Misawa that year. One of TA's trucks was full of deice fluid, and the other had been used for washing an aircraft several days earlier. Well, this wash truck was still half full of soapy water. Mistakenly, this washing solution was thought to be deice fluid. TA filled it up the rest of the truck with real deicer. We got the truck with the 50/50 soapy water and deicing fluid!

After deicing the tail section, the engineer came into the aircraft and closed the crew entrance door to prevent deicer from getting in the aircraft. As bulldozers continued to remove snow from the runway, he monitored the last of the deicing from the center escape hatch. It was now dark. The snow was still falling heavily as we prepared for engine start. We had a full cargo load and a snow covered runway. With the RCR, the engineer figured critical field length at 7,000 feet Over 1,000 feet to spare beyond the actual runway length No problem. As we continued with the before-starting-engines checklist, the loadmaster (outside the airplane) reported that the airman out there with him refused to pull chocks.

The pilot asked, "What's the problem?"

"He says he won't pull the chocks because there is ice on the plane."

"What ice is he talking about?" inquired the pilot.

"The ice on the side of the airplane," said the loadmaster.

As they carried on this conversation, I looked back at the No. 4 prop and could see icicles hanging off the blades against the backlighting of the ramp lights.

"Pilot, there are icicles on the props! Something ain't right!" I said with a slight wavering in my voice.

We all got out and started looking at the aircraft we had just thoroughly deiced. It looked like a big bundt cake with whitish icing pouring all over it, streaks running down the sides. Icicles hung off props and wingtips. Wow! Something was really messed up! The engineer, pilot, and I got real quiet for a minute as we at each other with wide eyes. We all suddenly realised that the young airman who refused to pull chocks had probably just saved our lives.

I could just picture us starting engines and taxing out into the darkness. The sheet of ice on the flight controls would give way to 3,000 psi of hydraulic pressure, and we would never suspect a thing. As we rolled down the runway, acceleration would be normal. But when I said "Go" and the pilot pulled back on the yoke, nothing from that point on would be as predicted. With all our lifting surfaces covered with a layer of ice, plus the extra weight, I started to wonder how many knots above our charted take-off speed we would need to limp into the air. Would be able clear the hills at the end of the runway or make the minimum climb gradients? What if we lost an engine after take-off?

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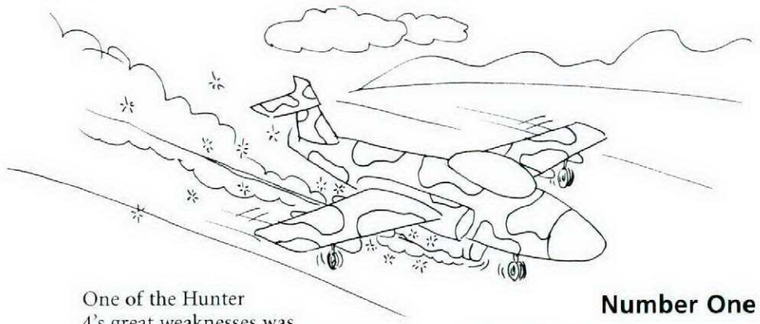
Blast From The Past

You are on fire!

Exercise Vigilant resulted in an unprecedented series of events on May 25th when 3 aircraft were involved in serious accidents in the course of 10 minutes. In 1958 Boz Robinson was a young Flight Lieutenant serving at Horsham St Faith. To this day he can vividly remember the events of that day ...



One of the Hunter 4's great weaknesses was that it was under powered and at height and in a tight turn the engine would tend to surge. This is exactly what happened over the North Sea to Tony Hilton who, along with me, had been scrambled at dawn from Horsham St Faith on the first day of Exercise Vigilant. Tony shut the engine down and set course for a return to base not realizing that the surge had been caused by the increase in the angle of attack and the reduced power setting he had applied and that he had shut down a perfectly serviceable engine.

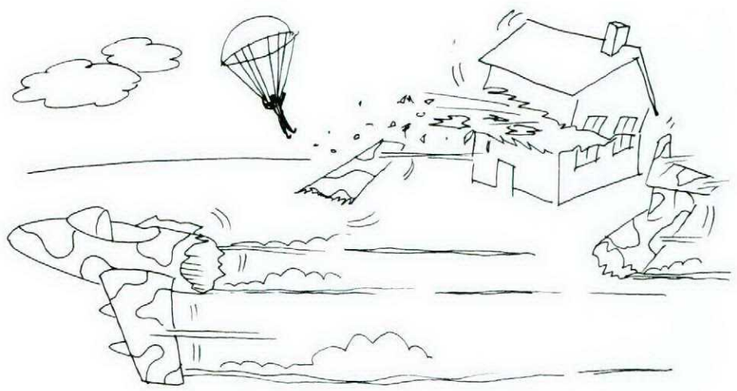
Meanwhile a Javelin of 141 Squadron which was based at St Faith for the duration of Vigilant had been scrambled too. It was fitted with 2 'bosom' tanks and as it started to taxi the front attachment of one of them failed, allowing the tank to swing down about its rear mounting. Because of the large delta wing the tank failure was hidden from the sight of the crew and the pilot taxied on unaware of the problem, pushing the nose of the tank along the ground, the noise of this being overcome by that of the engines. The rough surface of the taxiway quickly wore a hole in the tank, there were sparks and the fuel caught fire but mercifully did not explode. The Javelin continued to taxi trailing flame and black smoke.

Number One

Whilst this was going on, Tony Davies in another Hunter was in the process of taking off when he heard Air Traffic's urgent call 'You are on fire!" on the station frequency. Thinking the warning was directed at him Davies aborted takeoff and overshot the runway, smashed through the fence on the edge of the airfield, skimmed across the main road which runs alongside its western boundary and pancaked in the ploughed field opposite with the Hunter's tail overhanging the grass verge. Fortunately there was no traffic about at the time! The station's emergency crews roared off towards the incident although thankfully Davies escaped unscathed.

Number Two

The shouted 'on fire' message was also heard by Tony Hilton who was, you will recall, on his way back to St Faith with a Perceived engine problem and he too thought the message was directed at him. He decided to get down as quickly as he could, turned in short, blew the wheels down and without ceremony force landed across the airfield. He put the Hunter down hard. It bounced and broke up, the impact fracturing the fuselage behind the cockpit and simultaneously firing the primary charge of the ejection seat. As he shot upwards, his elbow partly severed in the process, the aircraft continued to slide along the ground. The wing sliced through an airmen's hut providentially missing all the occupants. It went on to demolish several bicycles. Tony Hilton's parachute had deployed meanwhile and he floated back to earth, landing in front of the bemused ambulance and fire crews who were rushing to the assistance of Tony Davies. (Tony recovered fully from his nasty injury).



Number Three

The Javelin pilot watched all this going on, saw red Very flares being fired and people jumping up and down gesticulating madly but still did not associate the activity with anything that was happening to his aircraft. He continued to taxi but by now the navigator was complaining about feeling hot. The pilot confirmed the temperature control was at 'full cool' – and then noticed the orange tinge to the edges of the canopy. Realization dawned and the crew hastily evacuated, climbing along the nose and dropping the 14 feet to the ground. The only injury sustained, was to the pilot's feet through landing in the running position! The aircraft burned, without exploding, to a pile of ash leaving a conspicuous delta outline on the ground. Horsham St Faith was closed for 2 hours.

I could not believe what I saw when I returned to St Faith! There was the most extraordinary sight of smoke, wreckage and devastation. There were still a lot of us in the air in our exercise marked, white finned Hunters. We had all found plenty of targets and had pushed our fuel to the absolute limits. Coltishall was out of action: its runways were being resurfaced and we could get nothing out of a shell shocked ATC at St Faith so we went to West Raynham praying that our fuel would last but found that here Air Traffic were totally preoccupied with something like 16 aircraft waiting to land. The fuel situation demanded that we find a suitable gap amongst the Meteors, Meteor Night Fighters, Javelins and Hunters and get down. Having landed it was literally a case of steering amongst aircraft that had rolled to a halt out of fuel! ◆

Reproduced from Talkdown, the magazine of the Norwich Airport Aviation Group and 74 Sqn's history book

OSH Answers... FREE on the WEB !

Hamilton... The Canadian Centre for Occupational Health and Safety (CCOHS) has launched a free occupational health and safety (OH&S) information service on its website **www.ccohs.ca.**

The CCOHS Inquiries Service, which has answered over 200,000 OH&S telephone inquiries from Canadians over the years, has created the new service in order to disseminate information to many more people. Inquiries staff have compiled the most frequently asked OH&S questions they've received over the years and posted them, with the answers, on CCOHS' website. Now anyone can help themselves to this information at anytime.

The questions represent the concerns of working Canadians, and reflect current occupational health and safety trends in Canada and abroad. The answers are the result of research by CCOHS' subject specialists, who consult the most reliable sources, and evaluate and summarize the information in simple, non-technical language.

Main headings in **OSH Answers** include: *Chemicals & Materials; Ergonomics/Human Factors; Diseases, Disorders and Injuries; Personal Protective Equipment; Canadian H&S Legislation* (including WHMIS); *Information Resources & Referrals* and many more. **OSH Answers** covers over 100 topics, answering more than 1,000 questions. The repertoire will steadily grow as CCOHS continues to handle inquiries from all over Canada. ◆

For more information contact CCOHS' Inquiries Service at **1-800-263-8466** (in Canada only) or e-mail inquiries@ccohs.ca.

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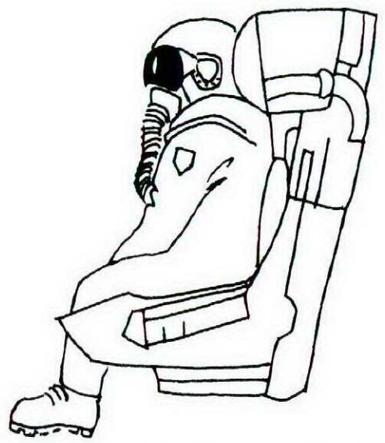
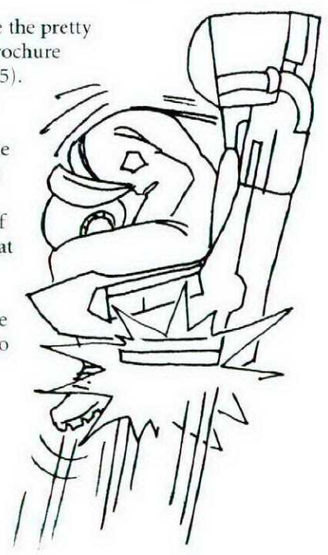


What your mother never told you

By WG Cdr Nick Spiller: the Command Flight Safety Officer

This is it! Straps tight. Head back in the head box. Back nice and straight. Check that the Nav/Pilot has his head clear of the canopy. Give the handle a good pull.

Wow! Don't believe the pretty pictures in the sales brochure (or in Air Clues Aug 95). This is what it's really like! 40,500 lbs of thrust (That's about the thrust of one Phantom FGR 2 in fall reheat or the maximum thrust of 8 Hawks) taking the seat up the rails. You are pushed down inside the straps with the spine bending like a hairpin to absorb the shock. It is impossible to achieve this position without the 20 G of ejection.

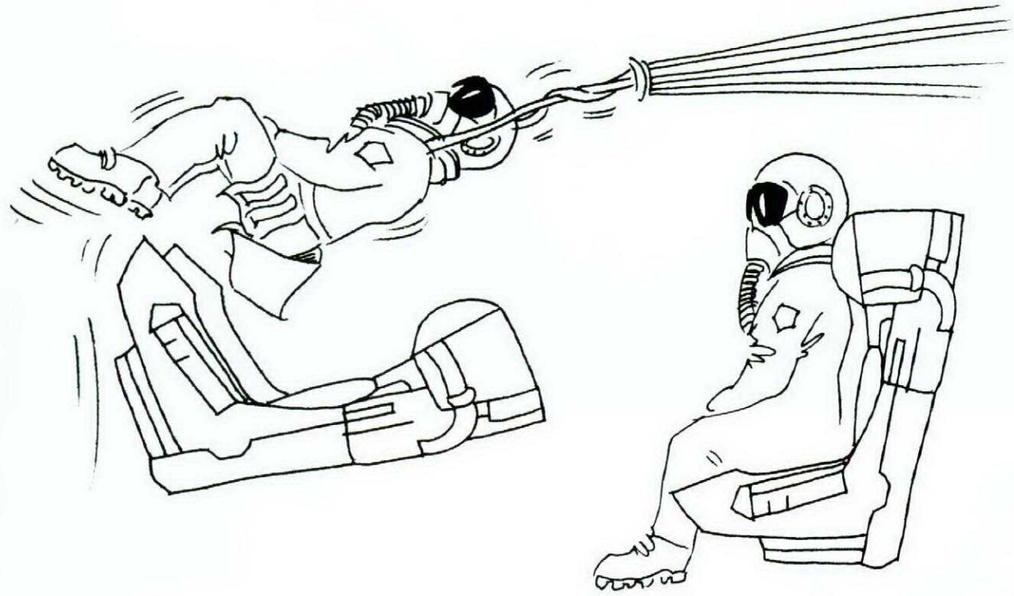


Heard of compression fractures? This is when they occur. The front portion of your vertebra are squeezed together by the unnatural bending of your back and some receive hairline fractures.

Don't believe it? We have had several cases of the top of flying helmets being damaged by the seat pan assembly!

Ouch! You hit the windblast. At this stage, you are still travelling at the same speed as the aircraft. The windblast throws you back into the seat, extending your body up and back against the straps and seat. Your head should go neatly into the centre of the padded headbox but, if you are tumbling, it could hit the comer of the headbox or miss altogether. Some people lose consciousness at this stage.

Sit too high in the seat and you risk your head going right back over the headbox and the lower rear of your head striking the solid metal bar on the top of the seat. This can be fatal.



Snap! The parachute pulls you clear of the seat. If the seat has been tumbling (which is more likely if you eject during a rolling manoeuvre or spin) then there may be some whiplash as you are jerked straight by the parachute. Quite often the risers become twisted, as seen here, during parachute deployment. As these straighten, you will be twisted round. Your helmet may snag on the unwinding risers, perhaps causing damage to your visor or dislodging your oxygen mask. The brain hates these rotational forces!

Frightening? You'd better believe it! But it all takes less than 5 seconds, and it is infinitely better than dying in the wreckage.

WHAT CAN GO WRONG?

Pins? *Two people in the last 25 years have died because they forgot the seat pins.*

Sitting height? *If you are sitting too high in the seat, like this individual, then when you hit the windblast you risk your head being hyper extended over the top of the head box and fracturing your skull on the reinforced top of the seat.*

Leg Restraint? *If you don't take the slack out of your leg restraints then you risk your legs bouncing up and hitting the bottom of the instrument panel or the coaming.* ◆

Reprinted courtesy of RAF Strike Safe issue 52

THE BOTTOM LINE

- *Ejection seats save lives.*
- *Always eject in time.*
- *Always strap in assuming that you will have to eject.*
- *If time permits, make sure that the front/rear seater is ready and clear of the canopy.*
- *Have a clear plan for Command Ejection.*
- *Sit at the correct eye datum height even if this means your thighs are not in contact with the seat cushion. Better a broken leg than a fractured skull.*

Best of the Rest

"Both starboard engines have gone!"

The early morning Alpine cloud was grey and bumpy as the heavy Boeing 707 struggled for altitude. Laden with fuel and mining equipment, the freighter's multinational crew was anxious to climb out of the turbulence and into the clear blue sky they could glimpse above 33,000 feet. Suddenly, with a loud double report the aircraft rolled hard right.

Streaming fuel, the stricken airliner started its final descent. In the cockpit, the copilot's mind flashed back 24 years. By a one in a million chance, that earlier day he had seen a 707 which, having shed an engine, was then consumed by flames. Were they to suffer the same fate? Only the greatest of teamwork and superlative flying skill could save the occupants. Were they up to it? Within half an hour they would know...

The highly experienced crew had worked together for just two weeks. Captain Ingemar Bergelund, a Swede in his mid fifties, had logged 25,000 hours on many airliners, including a decade or more on 707s. His 43 year-old English first officer Martin Emery had previously followed brief careers as air traffic controller and flying instructor, and had amassed 16,500 hours, more than half of them on big jet transports, including 4,500 on 707s. Flight engineer Terry Boone, also a Brit in his early fifties, had over 18,000 707 hours. All three were very experienced in Third World long-haul air cargo operations, and during the past fortnight they had circum-navigated Africa several times.

A long-haul charter pilot's life is never easy but some days can be worse than others. Martin describes the start of 31st March 1992 as "Bloody awful." It began with a 4am wake-up after a brief rest at a small, cold out-of-town pension (having been displaced by a conference from the airport hotel the previous day) and a long taxi drive in the dark along the winding, hilly road to the airport.

Their aircraft was 5N-MAS, a thirty year-old, sixty thousand-hour, Nigerian registered veteran. This ex-Pan Am, ex-Iran Air, ex-Uganda Airways, ex-DanAir Boeing 707321 had subsequently been converted to a freighter and owned by a succession of mainly British freight companies who used it predominantly for high-weight, long-distance flights across the North Atlantic as G-BFZF and G-BNGH. The aircraft had recently been acquired by the Kano-registered Nigerian company Trans-Air Ltd for an African charter freight operation based in Luxembourg. Its planned flight that day as QNK 671 was from Luxembourg to Lagos (Nigeria) with a full load of nearly forty tons of petromining equipment for Esso, then on to Accra (Ghana), Bamako (near Timbuktoo in Mali), and onwards as the available loads dictated. Despite their earlier tribulations, the crew managed to push-back on schedule at 0700 UTC.

The 707's maximum takeoff weight is 151 tons. With 59 tons of fuel in its tanks, 5N-MAS weighed all of that as its four high-hours but reliable JT3D3B turbofans gradually accelerated it along Luxembourg's 4,000 metre Runway 24. Generally reckoned to have been drawn by VC-1 0 rivalling salesmen, the 707's takeoff performance charts were always optimistic. Most of us familiar with the lumbering beast have seen enough high-speed closeups of the far-end approach lights to last a career, but this run was even longer than usual as the heavy machine struggled into the windless sky at the very end of the runway. The marginal departure was witnessed by, among others, some English construction workers fitting the new control tower's cupola. They waved to the crew as the Boeing

taxied past and one took a photograph. He later told Martin "You used every inch of that runway on takeoff'. The aeroplane became airborne at 0715z.

Making use of a runway-end valley to accelerate, the crew retracted the Boeing's flaps. Their smoke-trailing Pratt & Whitneys, belying the 'hush-kitted' stickers on their flanks, howled with the combined thrust of 72,000 pounds, as they thundered ahead through the dawn twilight. An understanding air traffic controller cleared them in a straight line direct to Saint Prex VOR (SPR) climbing unrestricted to Flight Level 290. Using their twin Omega long-range navigation sets, the crew set course towards the distant VOR beside picturesque Lake Geneva.

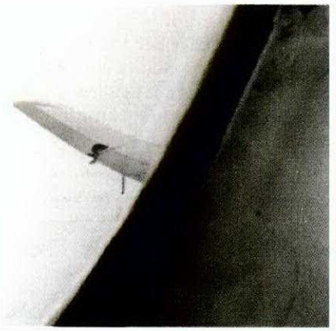
Nearly an hour later, as they crossed the Swiss border, they had reached FL290 and achieved a cruise speed of Mach .80 (or 300 knots IAS) as they turned south, on track for Martigues (MTG) Martin describes the ride as they approached the Alps as "Rough as hell in very dark stratiform cloud. Although it was turbulent, we saw nothing on our radar; I think the bumps must have been caused by mountain waves. We were all wearing our full five point harnesses, with our seats raised up and forwards to see outside. The Captain reduced speed to .78 Mach because of the turbulence and, as old autopilots are prone to dropping out from time to time, he had his hands on the control wheel to intervene immediately if that happened or in case the autopilot couldn't cope."

Here I should mention that the 707's single 1950s technology autopilot has limited abilities, even when maintained to perfection. Although supposedly capable of holding heading and height, tracking a VOR radial and following an ILS it does none of these things with modern digital precision, and frequently makes bigger control inputs than one would hope for. The manufacturer's proud boast was that it could apply automatic up elevator in turns!

In an attempt to get above the turbulent cloud layer, Martin requested Flight Level 330. The aircraft was really a little heavy to achieve this altitude immediately, but the crew hoped to make a gentle cruise-climb to get out of the increasingly rough cloud. (A new 707 was only ever stressed to +2.5 and -1 G). Martin describes the usual 707 turbulence symptoms of flexing wings, nodding, flailing engine pods and constantly-changing airflow sounds as they jerked and lurched their way through the bumps. "It was much too rough to write, so I stowed my flight log beside me and concentrated on looking out for a break in the clouds. As they slowly staggered on up past 32,300 feet, the grey sky above gradually became lighter, with occasional glimpses of blue, so they knew they were nearly clear.

The amber light and tone of the altitude alerter had just indicated 700 feet to level-off when suddenly, shaking itself like a wet dog, the big jet staggered under the near-simultaneous dual hammer blows of two deep, dull, muff led thuds. As these twin tremors resounded through the entire airframe, the aircraft quickly rolled through more than 45 degrees in heavy buffet (an angle one would never approach in such an aircraft, let alone in the vacuum-thin air of extreme altitude).

Quickly refocusing on his artificial horizon, Martin could hardly believe his eyes as he saw the bank rapidly increase past 55 degrees. Thinking his gyro must have toppled from a major electrical failure, he immediately looked across at the battery-powered standby instrument, but that confirmed the aircraft's perilous attitude. At the same time, with lightning reflexes, Captain Bergelund disengaged the autopilot, and held full left aileron and rudder to try to get the stricken freighter back to an even keel.



The flight deck was a cacophony of noise as the autopilot disengaged warbler mingled with the deafening engine fire bell below the flight engineer's table and a variety of tortured structural and airflow noises from behind and outside. Both Martin and Terry the engineer attempted several times to silence the fire bell by pressing the cancel button on the glareshield, but to no effect. Warning lights illuminated and flashed. Over the bell's din a strident horn began signalling increasing cabin altitude and dwindling life-supporting oxygen for the crew's lungs.

The aeroplane was descending fast, slipping down half sideways on the ragged edge of control, and perilously close to a 'jet-upset' when its increasing Mach number would rapidly render the manually-powered controls immovable even under the two pilots' combined efforts.

After a few seconds turmoil the Captain regained control of the wounded war-horse (although ninety degrees off course to the right) and reduced speed to its 230knot Va (the maximum for full control deflection, which is also the recommended structural failure speed). It was clear that something was terribly wrong with their aircraft, but in one particular respect they were lucky it was a 707, not a later type.

For the 707 is the only big jet airliner to have manual flying controls. Operated by old-fashioned cables, pushrods, bell-cranks, sprockets and-bicycle chains, and aided by balance panels and servo tabs, these are a tribute to the skills of Boeing's aerodynamicists, More importantly for our crew, they will still continue to work regardless of what subsidiary systems may have been lost. The only artificial assistance is a hydraulic jack to boost rudder deflection and reduce the engine-out control speed (Vmca) to a safe minimum.

But, before the crew had time to reflect on this, they were back in thick cloud and heavy turbulence, off course, and descending rapidly in a crippled craft towards the highest mountains in Europe. More recent big-fan equipped Boeing airliners can maintain a reasonable height on the power of just two engines, but the 707 is not so lucky except at very low weights. Having burned off ten tons of fuel since takeoff, 5N-MAS now weighed around 140 tons (minus a few tons of engines) so its three-engine drift-down height (the altitude it could maintain with maximum continuous power on the three remaining engines) would be below 20,000 feet. Its two engine drift-down height was likely to have been subterranean.

What the crew did not yet know, but would soon find out with a horrified shock, was that they had lost both their right engines. That is, they had not just been robbed of these engines' thrust, which would have been hazardous enough, but they had shed the entire power-plants, pods, supporting struts and all. With them had gone two of their four electrical generators, one of the two main

hydraulic pumps, two sources of bleed air and two of the three cabin air compressors. So, to compound their problems, the normal undercarriage and flap extension mechanism was lost, the electrical system was severely degraded and cabin pressurisation was failing. Oh, and fuel lines were severed and the integral wing tanks ruptured, but this would not become evident for a few minutes yet.

Doing their best, numbers one and two engines on the left wing were producing maximum continuous power as, not yet knowing the exact condition of their aircraft, the captain tried to minimise height loss and called for the fire drill. Martin and the engineer carried out the memory items, first for No 4 engine then for No 3, but they were perplexed that both right-side thrust levers (throttles) had slammed to the front of their quadrant . Pulling the No 4 fire handle to cut off the fuel, electrics and air supplies from the outboard engine, they did not at first touch the inboard engine's fuel cutoffs, because they wanted to take advantage of whatever power it might be able to give them and retain its hydraulic pump and electrics. (Only a 707's inboard engines have hydraulic pumps, and number three's generator normally supplies power to the essential busbar for the Captain's primary instruments).

Each crew member was fully occupied with his own tasks. The Captain was working physically very hard, wrestling with the heavy controls to hold the aircraft on their new westerly course while trying to asses their situation. The engineer tried to figure out which systems had been lost, and what the ramifications were. Completing the 'vital actions', Martin looked out of his side window to check the outboard engine for signs of fire.

He will never forget that sight. Although they were still in cloud, it was clear that, where the outboard engine and its pylon should be, there was nothing but a gaping hole in the leading-edge. Shocked, Martin swung back to the captain and said "Number four is missing!" Then he had a sudden thought and, twisting back to press his left cheek hard against the thick glass (for it is almost impossible to see a 707's inboard engines from the cockpit) he could just glimpse the ragged gap left by the No 3 powerplant. He called louder "Both starboard engines have gone!" Terry the engineer replied, in the language of these occasions "Come on Martin, don't muck about joking, things are bad enough already." Martin quickly transmitted a Mayday call, briefly explaining their situation, requesting the minimum safe altitude (MSA) in their area and radar vectors to, a landing. ATC did not seem to understand the seriousness of their plight, and kept asking for their position, something Martin hoped to get from them. He explained their structural problem and declared 'limited manoeuvring' but still got no useful response.

This realization gave Martin a horrible feeling of deja vu for, as a young air traffic control cadet, he had been in a training unit near the liftoff end of Heathrow's Runway 28 Right on that summer day in 1968 when Australia-bound BOAC 707 G-ARWE had shed its burning number three engine into a Staines reservoir. Martin had alerted ATC that he had seen the engine ablaze; and witnessed the staggering airliner's abbreviated circuit and approach, dragging a trail of yellow flames and thick black smoke across the hazy sky, to land downwind on Runway 05, where it burned out in a series of small explosions, killing four passengers and a stewardess.

It now became chillingly clear to Martin that they themselves were in a similar situation, and only the greatest of their combined skills, mixed with considerable luck, would save them. Eventually convincing the others of their plight, he cut off the fuel to the second right-side engine (but still could not silence the fire bell) and then carried out the remainder of the fire drill's 'cleanup' items.

At the same time he was repeatedly making Mayday calls, using the call-sign 'Mayday 671' because "I didn't want to die trying to get the phonetics right" but he got little help and suffered a series of frequency and squawk changes. Exasperated by ATC's poor grasp of the situation and lack of assistance, and irritated by the constant interruptions of other French-speaking aircraft, he finally set the transponder to 7700 Ident and concentrated on establishing their position and calculating an (MSA)

During this activity it occurred to him that, with a severely disabled aircraft, old flight data and cockpit voice recorders, and an uncomprehending air traffic control, they were likely to perish without anybody ever knowing why. So he pulled out his camera and took a photograph of the damaged right wing.

At 22,000 feet they popped out of cloud to see snowcapped peaks all around, and a further cloud layer below. Fortunately they still had clearance over the Alps, and were able to steer visually around the mountains to leave the high ground behind. Now some serious tactical decisions had to be made, so the captain handed over control of the barely manageable aeroplane to Martin for five minutes while he pondered their plight. It was clear that, even with power on its two remaining engines, the aircraft would continue descending, and could only remain aloft for a limited time.

A French controller provided a southerly heading towards Marseilles Marignane airport, and relayed the weather, while the captain gave the order to start dumping fuel to reduce their weight as much as possible. Meanwhile the flight and ground engineers laboriously wound down the undercarriage using the three manual hand cranks in the flight deck floor. However, it soon became clear from the pilots' radar that Marseille's into-wind Runway 32 approach was obscured by thunderstorms, and they dare not suffer any more turbulence. The captain suggested a right, turn for Palma, which was wide open, but his crew felt that it was out of reach.

Between them, they decided their safest course of action was to attempt a straight-in landing through the broken stratus onto the reciprocal Runway 14, despite a tailwind caused by the Rhone valley's Mistral. But Martin was still uneasy, and scanned his high-level chart for evidence of the better military fields he knew existed from his light aircraft touring of the area. The captain resumed control as Martin negotiated on the radio and the others found the relevant approach plates, then tuned and identified the radio aids. By this time they were down to around 8,000 feet on a high, wide left base with the wind blowing from their right quarter. The 707's maximum landing weight is 112 tons, but at this time 'AS would still have weighed about 135 tons, for which the emergency Vref (threshold speed) is 150 knots. Using the normal half-headwind increment (with a minimum of eight knots) they should have approached on four engines at 158 knots.

However the two-engine landing checklist requires an additional twenty knots to ensure that the aircraft remains under directional control. (Vmca on two engines is 152 knots if the hydraulic rudder boost is still working. The (Vmca on three engines without rudder boost is 161 knots, but nobody was sufficiently pessimistic to work out the minimum controllable speed with both two engines and rudder boost inoperative). The 707 requires extremely careful handing on two engines, and several have been lost in these conditions. Only the following year an RAAF 707 spun in from a low-speed demonstration Vmca sortie.

As they made their left turn onto Marseille's localiser, with an amazing stroke of serendipity, Martin glanced past his straining captain and saw below, through a break in the cloud, a long runway framed in the far window. "That would be better; land there" he called, while trying to establish from Marseilles approach where it was. It turned out to be no less than the 4,000 metre runway of the French flight test centre at Istres, a space-shuttle emergency landing ground. Perfect.

Marseilles Control handed them over to Istres Approach who asked their position. "Don't worry, we're overhead" replied Martin. "We are commencing a procedure turn, will call visual." So Martin helped his captain around a left teardrop turn to position cross-wind for a circuit to land on Istres's Runway 32.

Now Captain Bergelund was panting with the sheer effort of fighting the controls as their speed reduced. But they had to turn left, against the thrust of the operating engines, to reach the airport. Over the shrilling fire bell Martin called repeatedly for a turn but, between gasps for breath, the captain replied that he couldn't do it; in fact he could no longer even keep straight. But if he did not turn now they would all be buried in the good earth of Provence, and the exhausted captain seemed to be losing directional control, so Martin reached across and throttled back the two live engines. As the induced yaw swung the aircraft into a left bank, he

reestablished nearly full power on the inboard engine and opened up the outboard as much as he dared, to restore some control.

But now their increased descent rate, with only limited thrust to offset the drag of the landing gear, made an into-wind approach seem impossible. But even worse was to come for, as they slowed to extend the flaps by their emergency electrical system, there was an explosion. Fuel escaping from the ruptured tanks and lines in the right wing had been ignited by bare electrical wires protruding from No 3 pylon's socket. Most of the right-side flaps were blown away (the debris damaging the elevator), the wing spars were seriously disrupted, and the aircraft again began rolling right. Martin had to throttle back No 1 engine even more as the conflagration began eating away the trailing edge, further reducing lift on that side and making it ever harder to hold the aircraft straight.

As they broke through the cloud at 2,200 feet, trailing black smoke and flame, Istres tower twice warned them they were on fire and cleared them unrestricted to land onto any runway. Everybody now realised they had to get down immediately, which meant landing downwind. And they had just one chance to get it right.

Aligning the flaming aircraft with the runway and diving to get them there at their uncommonly high groundspeed took all of their combined skills. Captain Bergelund held a slight left bank with full left aileron and rudder and made small adjustments, while Martin modulated the power, retaining as much as possible on the inboard engine to keep them aloft. They dared not reduce airspeed below 200 knots for fear of losing directional control, yet they had thirty knots of Mistral tailwind. (The maximum permissible tailwind for landing a 707 is ten knots.)

Landing with only partial flap at 130 tons and well over 200 knots (on wheels and undercarriage stressed for only 112 tons at 195 kts) they touched down just past the numbers and slightly left of the centreline. Martin later said "I had never seen an airport go by so fast!" Trying to, get their speed under control, as they crossed the fence he relinquished the throttles to his captain and grabbed for the spoilers while they were still in the air (although only the auxiliary system-powered inboard spoilers would have worked). After touchdown Terry cautiously hauled up No 2 engine's throttle to maximum reverse.

anti-skid and spin-up protections it is not surprising that, even using careful short 'squirts', he eventually burst some of the tyres, but not before their speed was coming under control.

Captain Bergelund performed a perfect landing and kept straight as an arrow despite the lack of both hydraulic nose-wheel steering and differential braking but, with a tailwind, it was inevitable that they would eventually lose directional control as speed reduced. About three-quarters of the way along the runway the No 2 engine reverser inexorably pulled them off the left side and, with a wry smile, Martin recalls travelling fast across the grass to stop thirty metres short of a large steel DO NOT PASS THIS POINT sign. As they rocked and slithered to a halt at right angles to the runway, he became aware of a high volume of noise outside the aircraft.

During the rollout he saw the entire wing was an inferno of flame and boiling black smoke, and guessed

Reverse thrust should only be used symmetrically on the 707, but he rightly realised that, with no hydraulic brakes, the priority was now to get their careering juggernaut stopped.

Confirming that the normal foot brakes were u/s, the captain grabbed for the red emergency air system handle on his lower right instrument panel. Since this bypasses all the

that, although they were miraculously alive, they would not remain so for long unless they were very quick. Realizing he was the only one who had seen the fire, he shouted for

Terry to cut the fuel and electrics, threw open his heavy window, grabbed the evacuation strap above it, heaved this to the ground and, shouting "Evacuate, evacuate get out now", slid down it.

Before leaving, he was aware of Terry following him and the captain acting similarly on the far side of the cockpit. The loadmaster and ground engineer had to jump from the main entry door because its slide did not inflate. As he hit the ground Martin shouted to his colleagues "Come on you lot, bloody well run!" and stumbled forward to get away from the wreck. Looking back, he described the flaming hulk as looking like the Torrey Canyon, and was delighted to see his coughing fellow crew members stagger from the roiling black smoke like John Wayne gunslingers emerging from the embers of the OK Corral.

As they left, the fire service arrived to hose the airframe, first with water, then with foam. Thanks to their timely intervention the cargo was saved and the aircraft suffered little further damage, giving the investigating team good evidence to work on.

From first losing the engines to skidding to a halt took a mere 25 minutes, and it was still only just after eight thirty in the morning UTC Martin attributes their survival to "Bloody good team work" and says that, when checked by the doctors an hour and a half later, their adrenaline-charged heart rates were still up to four times higher than normal.

During a brief two-day enquiry (at which the crew apologised for melting the runway) their French hosts gave them lunch with wine and brandy. A KC135 (military 707) captain said "For this sort of emergency we evacuate en vol and parachute to safety, why did you stay with the aeroplane?"

"Easy," said Martin, "No parachutes!"

The two missing engines were later found 800 metres apart, 14,400 feet high in a Swiss mountain forest. Although the official French report has not yet been published, it appears that the root cause of the accident was a fatigue failure of one of No 3 engine's pylon mountings originating from an area of corrosion.

Editor's note: The following year the crew was awarded the Guild of Air Pilots and Air Navigators 'Hugh Gordon Burge Memorial Award. ◆

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To Intervene or Not To Intervene? The Copilot's Catch 22

Dr Robert 0. Besco (Capt AAL, Ret.) President, PPI (M00949)

Introduction and Background

A widely accepted cause of pilot error accidents in the last twenty years has been poor Cockpit Resource Management (CRM). It has become a well-established fact that the deficient and flawed attitude and knowledge components of pilot performance have been a major problem in CRM performance breakdowns (Arbon, Mouden, and Feeler, 1990; Besco, 1990, 1991, 1992, and 1994; Caesar, 1989; Cooper, White, and Lauber, 1980; Helmreich, 1990; Hurd, 1987; Lautmann, and Gallimore, 1987; Lederer, 1990; Nagel, 1988; National Transportation Safety Board, 1994; Office of Technology Assessment, 1988; Sears, 1989; and Wiener, 1989). Most Cockpit Resource Management training programs have focused on the personality conflicts and unsanitary small group dynamics of air crews (Helmreich and Foushee, 1993). Recently CRM programs are starting to provide a reemphasis on more operationally relevant contents of CRM training (Besco, 1994; Besco and Lederer, 1992; Helmreich, 1993; and Schwartz, 1987).

This paper examines the question of what specific knowledge, attitude, and skill components would be most beneficial to subordinate crew members when they must challenge the performance of a Captain. Such a critical situation can be very difficult for the junior crew members, especially if they are still in their new-hire, probationary period. If the organization is one that leads by fear, intimidation, and reprisal, all crew members will be very reluctant to tell an established Captain that mistakes are being made (Besco, 1989; Bruggink, 1989; Degani and Wiener, 1991; and NTSB, 1994).

A new component is suggested to be added to CRM training. "P.A.C.E." is the acronym used to define this new set of survival skills—Probing, Alerting, Challenging, and Emergency Warning.

These four steps form an ordered progression of inquiries designed to reduce risks at each level of the intervention sequence. The "P.A.C.E." skills will enable subordinate flight crew members to effectively intervene when a Captain is not performing up to reasonable professional standards. The "P.A.C.E." inquiry procedural steps will insure that the intervention by Copilots will always increase the margins of safety. The "P.A.C.E." intervention progression tools will never make a bad situation worse.

The Need for Enhanced Survival Skills

There have been many incidents and accidents in which the subordinate flight crew members had detected serious problems in the performance of the Captain. Subordinate crew members were aware of the gravity of the situation but were unable to select suitable responses to the perceived problem (NTSB, 1994). The Copilots and other subordinate crew members were not able to prevent crashes in the following fatal aircraft accidents:

To Intervene or Not To Intervene? The Copilot's Catch 22 *continued*

1. The DC-8 loss of control at Toledo, Ohio (NTSB, 1992);
2. The L-1011 wind shear accident at D/FW Airport, Texas (NTSB, 1986);
3. The HS-748 electrical failure in Pinckneyville, Illinois (NTSB, 1985);
4. The 737 out of Washington National, (NTSB, 1982);
5. The DC-8 fuel exhaustion in Portland, Oregon, (NTSB, 1979);
6. The 727 into Dulles (NTSB, 1975);
7. The DC-8 freighter into Cold Bay, Alaska, (NTSB, 1974);
8. The Convair into New Haven, Connecticut, (NTSB, 1972);
9. The L-188 into a thunderstorm at Dawson, Texas, (NTSB, 1969);
10. The LearJet out of Palm Springs, California, (NTSB, 1967);
11. The F-27 into Las Vegas, Nevada, (CAB, 1965).

These accidents are all examples of subordinates knowing that the Captain was denying serious risks and displaying counterproductive and unreasonably perilous behavior. These flight deck crews all knew that their respective Captains were either denying, discounting or oblivious to lethal dangers. Unfortunately, not one of them could do anything to change the Captain's behavior, performance, actions or strategies. Most of them could not even get the Captain to acknowledge the problem.

In several other recent accidents, the Copilots did not record any comments prior to the crash (NTSB, 1994). It is possible that these Copilots had detected the anomalies and were reluctant to speak up in any manner, i.e. caught up in the **"Copilot's Catch 22."**

The "Copilot's Catch 22' is:

22a. You are damned if you ignore a Captain's mistakes!

22b. You are damned if you do or say something about them!

The possession of "P.A.C.E." tools, skills, and procedures could have prompted these non-contributing Copilots to intervene with the non-performing Captain. It is also possible that the Copilots, cited by the NTSB, were also oblivious to the dangers their Captains were ignoring. It is possible that the Copilots lacked the airmanship skills and experience to even detect the problems, i.e. "they didn't know that they didn't know."

The critical need to take over the controls from an incapacitated or unconscious Captain has been recognized for years (Orlady, Kidera and Harper, 1973). The techniques for taking over the controls of the airplane from a dangerously dysfunctional but conscious Captain have never been well defined or universally accepted. The procedures for adopting a new strategy or flight plan that has not been developed by the Captain are also missing from current Standard Operating Procedures (SOP(s). **"P.A.C.E."** provides a hierarchy of intervention strategies for both situations. **"P.A C.E."** is effective when the Copilot is not flying the airplane (Pilot Not Flying (PNF) and is just as useful when the Copilot is manipulating the controls (Pilot Flying (PF). **"P.A.C.E."** starts with very general inquiries and progresses to a last statement that the First Officer is now assuming command and control of the aircraft.

Need for a Precise Language of Intervention

Subordinate flight crew members will use the "P.A.C.E." hierarchy of inquiry and intervention strategies to successfully cope with an extremely rare but potentially lethal performance break down of the Captain. First Officers trained and rehearsed in the intervention progression will initiate "P.A.C.E." when there is an indication of upper performance break down in airline cockpits. Creative ad-libbing, on the flight deck, will not be productive in life threatening situations. The commercial airline Copilot needs the equivalent message used by the military pilot. There is no misunderstanding, hesitation or mistake in the action to be taken when the wing man calls, **"Blue Leader, Break hard left, now!"**

The airline Copilot and the fighter pilot wing man share many duties and responsibilities. One is to protect the Captain or flight leader when the mission demands lead to a focusing of attention and narrowing of perception. It becomes a question of survival when threats and dangers emerge that fall outside of the attention span of either the airline Captain or fighter pilot leader. The Copilot and the Wing man both have a responsibility to protect their respective leaders from this potentially lethal form of perceptual narrowing.

Each step in the intervention sequence must provide ways to reduce the hazardous risks and to increase the probability of an uneventful resolution. Additionally, practiced intervention hierarchies can defuse the potential for open cockpit hostilities that could erupt when the Captain does not acknowledge perceptual narrowing, mistakes or performance decrements. Policies of every aviation organization must support a well defined hierarchy of intervention, in order for Copilots to be effective and accepted as protectors of the Captains "six o'clock position". The designs for the two-person cockpit in a complex long range aircraft have caused an even greater need for well-defined hierarchies. In the three-person cockpit, a confirmation system can be used in the intervention process similar to the voting systems used in auto-land fight controls. In the two-place cockpit, only established and accepted operational procedures will resolve the intervention conflicts and land the airplane safely on the ground.

The Need for the Structure of Intervention

Every airline organization needs to develop and implement its own specific **"P.A.C.E."** progression steps with standardized terminologies, semantics, and syntax. The structured phrases and the universally accepted definitions are to be used by subordinate crew members when they perceive anomalies. In particular, paying special attention to the opening statements in each step of the intervention hierarchy. The accepted wording for each progressive step needs to be learned verbatim by all seniority levels of flight crew members. These initial opening intervention statements should cover at least four steps in progression of increasing concern for the immediacy of the risks.

Intervention models and strategies must be structured so that the immediate flight safety threats are lessened by each step in the sequence. Steps in the progression should be made without fear that the statements will make the current situation worse. These communication patterns and skills must also enable junior crew members to inform senior crew members of their concerns without fear of reprisal to the subordinates, long term career security or promotion potential.

Not long ago, before the arrival of CRM, an unwritten but universal motto of Copilots was "Shut Up and Move Up." There was a twofold implication in that statement. First, it could be implied that when a Captain is doing something wrong, the Copilot should ignore it and let the Captain be grounded for his mistake. Secondly, it could be implied by junior crew members that if they were critical of a Captain, they could only lose by letting negative judgments become public. A corollary to this motto was the principle *"The key to success in this organization is to keep your critical opinions and lousy attitudes a secret."*

Table 1: The Green Eagle Code of Ethics

Don't sleep while your Captain is.

Encourage your Captain to smoke.

It's hell to fly with a nervous Captain, especially if you're the one making him nervous!

Don't interfere if your Captain absolutely insists on making a fool of himself.

Copilots Catch 22:

- You are damned if you ignore your Captain's mistakes.
- You are damned if you do something about them.

Keep your lousy attitude a secret.

Survival Rules:

- Don't fly with a Captain nicknamed "Lucky";
- Don't fly at night;
- Don't fly in bad weather;
- Don't mess with the red switches;
- Never, ever eat a crew meal in the dark.
- Speak very, very softly when you speak to your Captain.
- Don't make better landings than your captain, until the last trip of the month.

The two basic rules of a Captain's authority:

- Rule One. The Captain is always right.
- Rule Two. If the Captain is ever observed making a mistake, see Rule One.

When you upgrade to Captain, you must:

1. Accept responsibility for being right **all** of the time.
2. Compensate for all of those inept and disrespectful Copilots.

Keep your Captain out of the morgue, jail, FAA hearings, and Chief Pilot's office.

It's better to be down here, arguing about how you are going to do it up there; than to be up there arguing.

Always let your Captain be the first out the door of the airplane. After all, there may not be any stairs.

Buy your Captain scuba gear, skateboards, power tools and hot dog ski lessons.

As a Copilot, your primary job is to detect and correct mistakes:

1. First, your own mistakes.
2. Second, your Captain's mistakes.
3. Finally, everybody else's mistakes.

Never, ever awaken your Captain when he is smiling in his sleep.

Talk up the advantages of early retirement.

Don't expect your Captain to:

1. Pick up the meal check on a layover;
2. Be impressed with your flying background;
3. Think flying is more fun today than it was in the good old days;
4. Hear and understand the ATC request the first time;
5. Believe the FAA is doing a satisfactory job;
6. Buy anything without asking for an airline discount;
7. Wear a small-sized or a low-priced wrist watch;
8. Wear expensive uniform shoes;
9. Respect the competency of senior airline management;
10. Purchase his own newspaper to read on a trip.

To Intervene or Not To Intervene? The Copilot's Catch 22 *continued*

Table 1 shows a set of ironic ethical principles and codes of conduct for Copilots developed over 25 years ago. Known as The Green Eagle Code of Ethics, they were developed as a tongue-in-cheek political counter force to the organization of senior pilots known as the Grey Eagles. It was thought that the Green Eagles Code might help relieve, in a humorous way, the sometimes awkward relationship between Captains and junior crew members. This code also illustrates that CRM problems have their roots deep in conflicting organizational policies and practices.

Formal Written Policy Needs to Precede "P.A.C.E."

In all day to day activities on the flight deck, not just for crisis prevention, upper management must vigorously promote and actively support the participation of subordinate crew members in minimization of anomalous performance without threat of reprisal. American Airlines, for more than thirty years, has had a formal definition of Copilot responsibilities that undoubtedly has had a significant effect on supporting Copilots to advise Captains anomalies and errors.

> **"First Officer Responsibility:** The pilot occupying the First Officer position is charged with the responsibility of informing the Captain immediately and at any time, should he believe the aircraft is being handled improperly or placed in jeopardy. The Captain may choose to disregard this counsel, such is his command privilege, but no matter to what degree or how often such advice may be disregarded or ignored, the pilot occupying the First Officer's position will nevertheless be held responsible for **always** offering such advice." (American, 1983, emphasis added).

This policy, when practiced, protects the assertive First Officer from official corporate reprisal initiated by the Captain. Also, the Captain is denied the authority to order the First Officer to stop offering advice. Without this type of organizational support, the strategies of intervention will seldom operate (Mager and Pipe, 1984).

This type of policy makes it clear to both the Captain and the Copilot that one of the prime duties of the subordinate is to protect the "six o'clock position" or the blind side of the leader or Captain.

"P.A.C.E." Avoids Overemphasis on Personality Conflicts

Many CRM training programs have focused on the personality dynamics of the flight crew (Helmreich and Foushee, 1993; Helmreich, Predmore, Irwin, Butler, Taggart, Wilhelm and Clothier, 1991). The negative outcome of this mental health emphasis has been that many, if not most, crew members will not identify with these personality problems as the source of past CRM breakdowns (Helmreich and Wilhelm, 1989).

There is considerable scientific evidence that personality differences are not now and have never been related to pilot performance differences (Besco, 1994; Dolgin and Gibb, 1989; and Hunter and Burke, 1992). Since the majority of flight crews do not exhibit these poor characteristics of mental health, individual crew members will not acknowledge that the operational risks of poor CRM exists on their particular flight decks. Most flight crew members will reject the unproven academic theory that unsanitary mental health traits are the primary sources of these CRM errors. Consequently, crew members will judge that, as competent and reasonable flight crew members, they are not at risk to commit the same mistakes that the crews will commit when the crew contains domineering Captains, submissive Copilots or other aberrant psychological characteristics.

There is a reference to this situation drawn in the plot of The *Caine Mutiny* (Wouk, 1951). In this fictionalized account, the Captain was such an emotional cripple that the subordinate officers rejected his leadership. The crew of the Caine saw only two options: (1) mutiny or (2) mission failure by submission to a dysfunctional Captain. They chose mutiny over submissive compliance to a Captain they viewed as self destructive. The post-trial cocktail party soliloquy by the defense attorney has a lot of wisdom on the need to support a leader you do not like. These classic and eloquently written principles and concepts, on support of disliked leaders, should be integrated into the content of current CRM programs.

The need to structure training methods, procedures, and contents on the more operationally and organizationally based components of CRM breakdowns has been defined in recent years (Besco, 1994; Besco and Lederer, 1992; and Wiener, 1993). The aviation community will benefit when CRM training programs place the main emphasis on removing the organizational and operational barriers to effective CRM.

The resolution of personality differences on the flight deck will be, at most, a tertiary issue when the operational and organizational communications barriers are effectively reduced or minimized to a practical zero. **"P.A.C.E."** is the type of operationally based training program which will enhance crew performance in all aviation organizations.

"P.A.C.E." A Four Step Progression to Survival

Probe for a better understanding.

Alert Captain of the anomalies.

Challenge suitability of present strategy.

Emergency Warning of critical and immediate dangers.

"P.A.C.E."—Probing, Alerting, Challenging, Emergency Warning—is a four step progression going from an inquiry to a disaster warning. The progression is gradual and operationally relevant.

Each step is a building block for the next step. Each step serves as a non threatening signal to the Captain that a response to each step is required.

The examples below are **"P.A.C.E."** steps that could and should have been used by the Copilot of the HS-748 in the Air Illinois, night IFR (Instrument Flight Rules), complete electrical failure accident (NTSB, 1985). The aircraft departed Springfield in night, VFR conditions on an IFR flight plan through a line of predicted thunderstorms, to Carbondale, the final destination and corporate maintenance headquarters.

Both generators became inoperative shortly after takeoff while still in VFR conditions. The Captain elected to continue on through the frontal system on battery power.

Step 1: PROBING statement:

"Captain, I need to understand why we are flying like this."

Example from the HS-748 Copilot: "Captain, I don't understand why we don't maintain VFR (Visual Flight Rules), go back to Springfield and land before the battery goes dead."

Vernacular translation: "Captain, I think that you might be painting yourself into a corner and aiming to shoot yourself in the foot."

Step 2: ALERTING statement:

"Captain, It appears to me that we are on a course of action that is drastically reducing our safety margins and is contrary to both your briefing and to company's SOPs."

Example from the HS-748 Copilot: "Captain, if we proceed ahead, from VFR conditions into the line of heavy rain showers, on battery power only, we will crash because we have no way to fly instruments when our battery goes dead. We should not even be flying IFR with one generator inoperative, let alone flying night IFR into lightning and heavy rain showers with both generators inoperative."

Vernacular translation: "Captain, it is my job to protect your blind spots. I see you are about to walk off a cliff."

Step 3: CHALLENGING statement.

"Captain, you are placing the passengers and aircraft in irreversible and immediate danger. You must immediately choose a course of action that will reduce our unacceptably high risk levels."

Example from HS-748: "Captain, you are placing the passengers in a position of a certain crash when the battery goes dead. You must immediately reverse course and get back to night VFR conditions."

Vernacular translation: "Captain, you are about to self destruct. You have the equivalent of a very angry and armed bogey in your six o'clock position. We are all about to get the civil aviation equivalent of a 20 millimeter enema."

Step 4: EMERGENCY WARNING.

"Captain, if you don't immediately increase our safety margins, it is my duty and responsibility to immediately take over control of the airplane."

Example from HS-748: "Captain, if you don't immediately reverse course and get back to night VFR conditions, I must take over control of the airplane. I cannot allow you to subject the passengers to such an unnecessary and high risk of certain death. Under these conditions, it is my duty and responsibility to relieve you of your command."

Vernacular translation: "Captain, you, your airplane and every one on board are about to be dead meat. I choose not to join you. If you don't immediately cease and desist, I will take the airplane away from you. I owe it to myself, my family, our passengers, and our company to restore an adequate margin of safety."

P.A.C.E. Survival Step—
INTERVENTION AND TAKEOVER:

"Captain (Jones), I have the airplane !!

(Jerry), Take your hands off the controls, NOW!!"

(Spoken loudly, slowly, and with firm authority!!)

Taking Over Control from the Captain

A Copilot takeover of the active control of an airplane has more immediate and life critical ramifications than in any other complex systems operations environment. The cockpit of an aircraft is no place to physically wrestle over the controls. The operational etiquette or intervention hierarchies must be clear cut as to when the Copilot announces the intention to take command. There should be no doubt as to the appropriateness of the Copilot taking over the controls from the Captain.

The **"P.A.C.E."** steps—**P**robing, **A**lerting, **C**hallenging; Emergency Warning—require that the Captain make a satisfactory response to the Copilot at each level of inquiry and intervention. It should be an organizational SOP that if the Captain ignores the Copilot through all four steps of **"P.A.C.E."**, the Copilot must proceed to assume command" and control of the airplane.

For the actual announcement of change of command on the flight deck, the Copilot could use a phrase such as **"Captain (Jones), I must take over control of the airplane. (Jerry), take your hands off the controls, NOW!"** The use of a personal first name or a nickname can very effective to break the perceptual narrowing of the Captain. When a third crew member is present, they can use terminology such as, **"Captain (Jones), you must give control of the airplane to (Barry) immediately."**

To Intervene or Not To Intervene? The Copilot's Catch 22 *continued*

When the Copilot is already flying the airplane (PF), the **"P.A.C.E."** intervention steps **must** be used by the Copilot to announce the intention to implement a strategy not initiated by the Captain. Even though the Copilot has control of the aircraft, the Captain still has command responsibility for the basic flight plan and mission control. These same four steps of progression to intervention strategies must be followed by the PF Copilot to formalize the change in command and return the aircraft to the pre-planned margin of safety.

Conclusion

When the Captain decides to replace the Copilot on the controls of the airplane, the time honored"...I've got it" by the Captain is readily acknowledged by everyone. Unfortunately, there is no universally accepted procedure for the Copilot to use in taking over control of the airplane from a conscious but dysfunctional Captain.

What a Copilot needs is the commercial aviation equivalent of a universally understood communication, well accepted in the life or death teamwork of military fighter pilots. When a lead fighter pilot hears the words "Blue Leader, Break Hard Right", there is no doubt and no question as to its meaning. The lead pilot receiving this message will give no thought to group dynamics, assertiveness, personalities or the need for more information to reassess this situation. Also, there is no hesitation on the part of the wing man to intervene and alert the Flight Leader of any and all impending dangers.

The commercial aviation industry is overdue to develop ~ a universally accepted set of intervention TERMINOLOGIES, OPERATIONS, PROCEDURES, AND SYSTEMS for all flight crew members. The "P.A.C.E." progression is suggested as the model on which to build a hierarchy of intervention.

"P.A.C.E." is based on the following four steps:

Probing – for a better understanding.

Alerting – the Captain of the anomalies.

Challenging – the suitability of present strategy.

Emergency Warning – of critical and immediate dangers.

These four steps of intervention strategy—**"P.A.C.E."**—will help

"to make the world a better place in which to fly."

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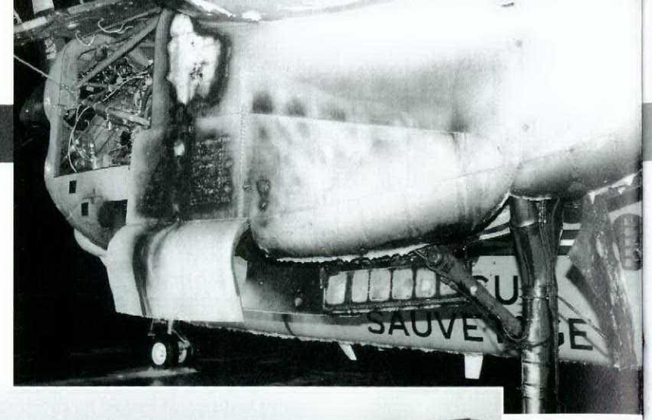
From the Investigator



TYPE: Buffalo CC115465
LOCATION: 19 Wing Comox
DATE: 7 Feb 98

Circumstances

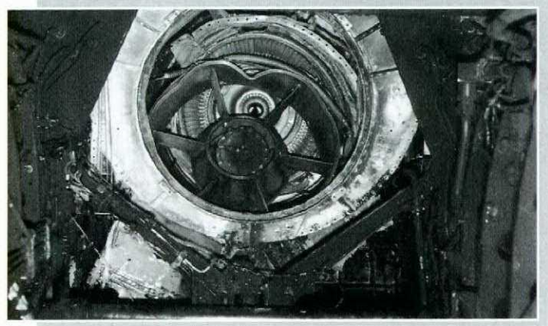
Buffalo CC115465 was scheduled for a High Power run-up following the replacement of the right hand propeller and the left hand engine Fuel Control Unit. Three qualified technicians were assigned to carry out the engine run-ups.

The run-up proceeded normally until the left engine Max Forward to Max Reverse Slam Check. During this check full forward thrust is applied to the engine being tested and, once stabilized, the power lever is retarded to Max Reverse within one second. As the throttle was retarded the engine exploded and a large fire engulfed the left nacelle. The crew immediately initiated the Red Page emergency checklist to deal with the situation but the engine fire extinguisher failed to discharge when the Fire T-Bar handle was pulled. Attempts to turn the handle to discharge the second fire bottle were also unsuccessful. The crew advised the tower of the emergency as they shut down the right engine and abandon the aircraft.

Several technicians working in Servicing noted the fire and responded to the scene after ensuring the Fire Hall had been notified. They brought a 50-lb Halon fire extinguisher with them and began fighting the fire. Fire trucks arrived soon afterwards and brought the fire under control using 160 litres of foam and 3000 litres of water. There were no injuries. The aircraft sustained "C" Category damage.

Investigation

Examination of the scene afterwards revealed that the two power turbine wheels were forcibly ejected from the bottom of the engine after destroying the power transfer shaft on which they were spinning and cutting through the turbine casing. When the turbine wheels were examined it was noted that all blades were missing. Several had been ejected through the turbine casing and had penetrated the engine nacelle and fuselage and were found inside the cabin. The majority of the blades were found forward and to the left of the engine. The front power turbine wheel was found over 600 feet from the engine.



Examination of the Engine Fire Extinguishing system revealed that the Squib charges that should have fired to release the extinguisher were shorted out by pieces of shunt wire inserted into the firing cap. These wires are installed for transport and storage of the charges to prevent accidental firing and should have been removed prior to installation.

Determination of the initiating event that caused this engine to fail is a high priority at DFS. The failure of the Squib to activate the fire extinguishing system was the subject of an immediate local SI to confirm that the Fire Bottles in all other CC115s would work when needed. As these devices are used in other fleets for similar purposes as well as in winch cable cutters and for deploying CPIs, a more widespread SI was recommended.

The FDR data is being correlated with the CVR tape to determine the sequence of events after the throttle was moved from Max Forward to Max Reverse. The Propeller Overspeed Switch was bench tested and found to be unserviceable. An analysis of the CVR will be attempted to determine the maximum propeller speed attained prior to the explosion. Failure modes of the power turbine blade are being researched to ascertain if any failed as a result of centrifugal loading. ◆

TYPE: Air Cadet Tow Plane C-GCDL
LOCATION: Innisfail, Alberta
DATE: 28 Jul 97

Circumstances

The flight was the first tow mission of the day at the Prairie Region Gliding School. After an uneventful take-off, tow, release and circuit the tow plane set up for landing on the grass to the east of Runway 16 at Innisfail, Alberta in accordance with standard operating procedures. After a normal touchdown on the grass and braking to slow the aircraft, a slight turn to the right was initiated at low speed to position the aircraft on the runway for the next tow mission. After approximately 50 degrees of turn the left landing gear leg broke off. The failed leg pivoted upwards causing the tire to strike the aircraft on the aft portion of the front left windshield and side window leaving a distinct tire imprint. As the aircraft settled to the ground the propeller cut into the earth stopping the engine. The left wing tip also struck the ground and was bent upwards. The solo pilot shut down the aircraft, secured the switches and egressed unaided. Fortunately he was not injured.

Investigation

A visual inspection of the fracture surface revealed clear indication of a fatigue crack on the underside of the leg just inboard of the flat plate that secures the leg to the fuselage. This leg had previously been inspected using a Magnetic Particle Inspection (MPI) process during the Scout Structural Inspection and Repair Program (SSIRP) approximately 450 flying hours prior to the failure.

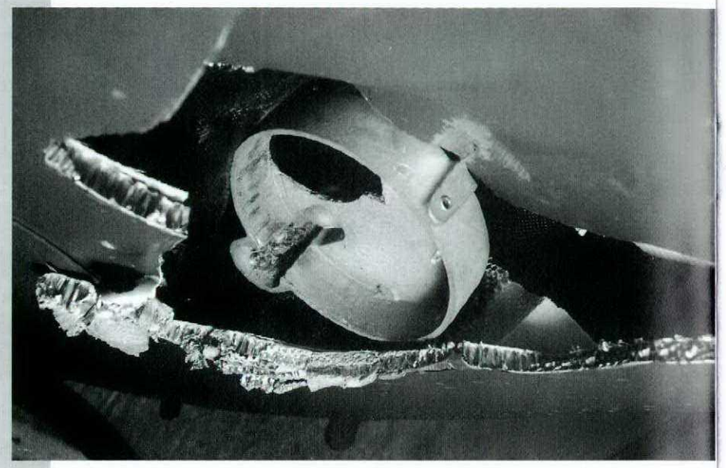
A Supplementary Inspection was initiated on all other Air Cadet Gliding Programme Scout aircraft to determine if any others were similarly affected. Four other legs showed signs of similar cracking and are undergoing further analysis at QETE. All landing gear legs were either changed or passed the MPI inspection. Investigation into the field conditions where the Tow Planes operate at Innisfail is ongoing to determine what if any effect it may have had in this occurrence.

DFS Comments

While it would be ideal that we not suffer component failures that result in damage, we were indeed fortunate that this component failed when it did. As the aircraft had slowed to taxi speed, the consequences of the failure were not as serious as if it had failed at a higher speed. Although this aircraft is designed for operations on rough surfaces, the number of take-offs and landings per hour carried out in our operation of the aircraft is unique. Hopefully the aggressive and proactive maintenance programme that all Regions have in place will identify components that are likely to reach the end of their safe life before the manufacturer's recommendation. ◆

From the Investigator

TYPE: CH146 GRIFFON 146480
LOCATION: 17 NM SSE Cold Lake AB
DATE: 16 April 1998



The crew was conducting a night Visual Flight Rules (VFR) navigation mission without Night Vision Goggles (unaided). Prior permission had been obtained to conduct a confined area landing on private property during the training mission. An earlier daylight recee had been conducted by the Aircraft Captain (AC) which identified two possible landing sites on the property. The primary site was occupied with heavy equipment on the night of the sortie and the alternate site was chosen for landing. The crew was briefed by the AC using a hand drawn map which contained detailed information but did not note the presence of a 24 inch high by 6 inch diameter steel fresh water well casing in the middle of the alternate landing site.

The aircraft arrived over the intended landing area and circled it at about 500 ft AGL and 60 KIAS. The confined area checks were completed during a downwind racetrack pattern and a two-stage approach was started with the 40 foot trees north of the landing site identified as the barrier to cross. Once successfully clear of the barrier trees, a high hover was attained but trees to the right side of the aircraft were a little too close to commence the vertical decent. The high obstructions were cleared as the AC manoeuvred the helicopter left. The landing light was deployed to the front of the aircraft and the variable spot light was aimed towards the right to illuminate the high trees located in that area.

An attempt to visually clear the landing area under the aircraft was hampered by the manner the aircraft lights were deployed and by the shadows cast into the area from in situ lighting. The aircraft, when clear of high obstacles, descended vertically onto the steel well casing which tore an 18 inch by 10 inch hole in the underside fuselage and damaged a stringer and fuel tank located in that portion of the aircraft. Upon hearing the noise associated with the damage, the descent was arrested and a low hover re-established. The well casing was cleared and the aircraft landed and shut down 30 feet to the north of the object.

According to the CH146 Standard Manoeuvre Manual (SMM), the procedures for night unaided confined area landings are different from the daylight and night aided procedures. The landing light shall be retracted to illuminate the under aircraft area and at least two low and slow approaches are to be flown in order to land in a confined area unaided. The investigation is continuing by examining the procedures for night unaided flight sequences and the training that crews receive at the Operational Training Unit and through On-Job-Training. ◆

Countdown To Disaster *continued from page 3*

They worked, to some extent. The inertia reel belts locked, and the seats and undercarriage absorbed some of the impact. But the damage from Black One's rotors caused the cabin roof to collapse under the weight of the motor and transmission. Fuel ignited and a fire broke out, but slowly, from the rear.

Some of the men were able to struggle out. Several then went back to drag out their mates, despite the explosions from the ammunition and the strengthening fire. Burke, his three crew and four SAS escaped with their lives from Black Two.

In its findings, the board sheets much of the blame to the inexperience of 26-year-old Hales, acknowledging the Black One pilot was the product of a highly stressed system struggling with unserviceable aircraft and high losses of experienced pilots to the commercial sector.

It is also critical of lack of supervision by superiors and of the poor communication between the SAS – with its penchant for secrecy – and the aviators who were less practised in counter-terrorism. The board also picked up on a 1994 report written by Major Jonathon Martlew, a former safety officer to the aviation regiment, in which he urged against a lax attitude to safety due to a "can-do culture".

Failure to report and investigate incidents properly would eventually catch up with them, warned Martlew prophetically, and "leave the regiment open to major criticism in the event of an external investigation into an incident". ◆

By Mr. Roy Eccleston

Could this be you?

It was a dark and rainy midnight shift; the only thing left to do was an engine runup. The engine techs had finished their walk around and were waiting for Bob to show up to ride brakes. He finally showed up and everyone got on board. Only then did Bob realize he had forgotten his headset on the serving desk. So, in a hurry to get the job done and maybe catch a few zzz's, he hopped on the mule and sped off to the hangar. The hangar doors were open as the aircraft was going to be towed in right after the run so Bob just sped into the hangar without missing a beat. Until he went to stop that is. He didn't realize that the wet tires combined with the painted hangar floor had him virtually driving on a skating rink. Well, you can just imagine Bob's surprise when he went to stop and five tons or so of speeding green mule slid across the floor heading straight for a big tool board. No number of Oh My God's, or Hail Mary's Bob said were slowing this thing down. After his whole career had flashed before his eyes and the mule had finally stopped, Bob stepped down from the saddle to see that he had come to a stop just inches from the tool board. "What if someone had been walking through here or checking the tool board ?" he thought. He quietly picked up his headset, concealing his shaking hands and returned to the aircraft. The run-up went without a hitch and all was going well until on the ride back to the hangar one of the engine techs on the run asked Bob, "How come you're driving so slow?" All he could say after thinking about what could have happened is "You don't want to know" ◆

De-Deicing *continued from page 5*

I had to stop. It was freezing out there on the ramp, and thinking about might have occurred made me shiver even more.

After 40 minutes, our crew and TA figured out what was going on. They called for the other deice truck, but it was too late. We were initially pushing a 16 hour crew day, and now with another deicing, we were staring at almost 18 hours. The aircraft commander decided we had had too much excitement for one night, and we called it quits.

As the aircraft commander canceled our flight plan, I started filling out the safety report. I stated that the airman launching us out had broken the "chain of events" that leads to every aircraft accident. I hope he realised the momentous decision he had made by refusing to pull our chocks. We thanked him as a crew and told him he had done a great thing.

In retrospect, my only regrets is that I cannot remember the name of the young airman who most likely saved my life. If he is reading this story, I want him to know I will never forget the actions he took that night on his tour in Japan. ◆

Reprinted courtesy of Flying Safety magazine October 1997

For Professionalism

Second Lieutenant Jason Nelder

Second Lieutenant Nelder, an undergraduate pilot in training, was on a solo training mission in a Tutor aircraft performing a practice forced landing exercise. When he attempted to retard the throttle to idle he noted that the engine RPM indicated 81 percent instead of the normal 63 percent. Further investigation by Second Lieutenant Nelder confirmed that full throttle movement would only vary the engine RPM between 81 and 100 percent.

Second Lieutenant Nelder quickly concluded that a successful landing required an engine flame out. He positioned the aircraft at an airspeed and altitude that would allow him to complete a dead-stick landing. At a distance of five miles from the aerodrome he flamed out the engine and executed a flawless engine out pattern and landing.

Second Lieutenant Nelder's calmness and professionalism when faced with an emergency situation allowed him to recover his aircraft safely. *Well done!* ◆

Corporal K.H. Smit

Corporal Smit, an avionics technician newly qualified as a start controller, was performing his first unsupervised night start after a desalinization and airframe wash on a Twin Huey helicopter. While conducting the start check on the number two engine, Corporal Smit noticed liquid in the vicinity of the fuel filter which easily could have been mistaken as wash effluent. He investigated further and concluded that the fluid was fuel leaking from the engine fuel outlet line.

Corporal Smit alerted the pilot who in turn shut the helicopter down. Detailed examination revealed that the number two engine outlet fuel line had cracked.

In night time field conditions, with substantial water remaining in the engine compartment from the airframe wash, Corporal Smit's professionalism and attention to detail revealed a dangerous fuel leak which undetected would have seriously endangered both the crew and aircraft. *Well done!* ◆

Captain Mike VandenBos

While conducting a cross-country mission to Bathurst New Brunswick, Captain VandenBos elected to do a Snowbird pitch at the Miramichi airfield. When he was at one mile final approach he advanced the throttle slightly and heard a thump. Captain VandenBos immediately zoomed the aircraft and headed directly to low key position for a forced landing. The completion of a compressor stall clearing procedure resulted in no engine response.

Captain VandenBos executed a flawless forced landing. After touchdown, as the EGT continued to rise, he placed the throttle to the cutoff position and allowed the aircraft to roll out onto a taxiway. Subsequent inspection revealed significant damage to a first stage compressor blade.

Captain VandenBos's timely, efficient, and professional reaction to a critical and unexpected loss of power prevented the loss of a valuable aviation resource. *Well done!* ◆

Corporal S. Brassard

Corporal Brassard, an aviation technician employed on peacekeeping duties in Haiti, was performing a nighttime "A" check on a Twin Huey helicopter when he observed something unusual about the tail boom left hand lower mount. To investigate further he requested an assistant to shake the tail of the aircraft, which caused the crack to open and be visible to the naked eye. Corporal Brassard immediately notified his crew chief and the aircraft was placed unserviceable.

Further examination revealed that the fitting had failed thus seriously compromising the structural integrity of the tail boom.

The inspection of the mount is normally conducted only on primary inspections. Despite the night field conditions, Corporal Brassard's professionalism, attention to detail, and comprehensive knowledge of the airframe, allowed him to identify a dangerous structural fault. *Well done!* ◆

Captain Richard Walsh

Following a formation takeoff, Captain Walsh was unable to fully retract the speed brakes of his Tutor aircraft. Noting that he had zero hydraulic pressure he broke formation, informed the lead aircraft, and declared an emergency. While initiating the checklist actions for an emergency gear extension, Captain Walsh noticed hydraulic fluid on the cockpit floor. A ruptured line had drained all of the fluid from both the normal and emergency systems rendering the landing gear, flaps, and speed brakes inoperative.

Recognizing the potential for a post landing fire, Captain Walsh began reducing the residual diesel fuel in the belly tanks as he continued his flapless, gear up approach. Captain Walsh shut the engine off prior to touch down, landed gently on the runway centre line, and kept the aircraft straight during the slide by using rudder. The aircraft came to a halt with minimal damage.

Captain Walsh's calm and thoroughly professional handling of a highly unusual and hazardous situation prevented the loss of a valuable aviation resource. *Well done!* ◆

Master Corporal Catherine Picard

During the summer of 1997, 10 Field Technical Training Squadron held a Hornet 30-day seat check re-qualification session. Master Corporal Picard was monitoring the candidates' level of comprehension in the practical phase of ground egresses. She noted one candidate making a serious sequence error in the ground egress procedure by omitting a crucial step. If the omission took place in an actual emergency the individual would be unable to escape from the aircraft.

Master Corporal Picard followed up her findings and discovered that the squadron was omitting this step in their unit training. She immediately took action to rectify the problem and notified the Wing Flight Safety Officer. Her actions were directly responsible for the development of a Wing Seat Check Standardization policy.

Master Corporal Picard's dedication, professionalism and immediate actions resolved an unacceptable situation. *Well done!* ◆

Corporal Douglas W. Dupuis

While preparing to load freight on an outbound aircraft, Corporal Dupuis observed a Hercules aircraft backing out under its own power from the embarkation facility. He noticed that the ramp support had been left in the loading position outside the aircraft and was in danger of being run over. Realizing the damage the support could cause to the aircraft, Corporal Dupuis immediately contacted his supervisor, who in turn passed a stop taxi message to the aircraft commander.

The aircraft was halted just in time to prevent having its main landing gear run over the now toppled ramp support.

Corporal Dupuis' expeditious and professional actions prevented serious and costly damage to a Hercules aircraft. *Well done!* ◆

For Professionalism

Corporal Craig S. Laraway

Corporal Laraway was carrying out an acceptance check on a recently arrived Hornet engine. While conducting his visual inspection he noticed a black object which looked like an o-ring wrapped around the sump scavenge line. On closer inspection, which included the removal of the line, he discovered that a blanking plug had been inadvertently left on when the line was installed.

The location of the line is in an area difficult to access under the engine between accessory components. A detailed inspection of this line is not normally part of the acceptance check, as the line fittings do not require torquing. Had the blanking plug remained undetected, it could easily have interfered with the safe operation of the engine necessitating extensive repairs and aircraft downtime.

Corporal Laraway's professionalism and attention to detail prevented damage to the engine and the loss of a valuable aviation resource. *Well done!* ◆

Captain Dave MacLean

Captain MacLean, an air traffic controller, was working the inner runway position in the tower at 4 Wing Cold Lake. He had recently come on duty and there was only one aircraft airborne – a locally based CT-133. The CT-133 crew had completed a local Opeval mission and was returning to base via a PAR.

At five miles on final Captain MacLean issued a clearance for a touch and go which was relayed to the pilot by the PAR controller. The pilot acknowledged the clearance including confirmation that the gear was down and locked. As the aircraft approached decision height, Captain MacLean picked up his binoculars and examined the aircraft configuration. Captain MacLean noticed that the landing gear was still retracted and quickly directed the PAR controller to advise the pilot. Captain MacLean immediately followed-up with an emergency guard transmission to overshoot. The aircraft climbed out and completed an uneventful circuit to a safe landing.

Regulations do not require controllers to visually check an aircraft's landing gear. Captain MacLean's professionalism and dedication to duty prevented a potentially serious accident. *Well done!* ◆

Second Lieutenant Patrick Gervais

Second Lieutenant Gervais was working as an operations assistant at 438 Squadron when he was informed that there was a need to drain fuel from a Starlifter located at the aerodrome. Second Lieutenant Gervais asked the civilian in charge of the defuelling what the disposition of the fuel would be. The contractor stated that the fuel from the Starlifter would be used to refuel the Squadron's Griffon helicopters.

Second Lieutenant Gervais immediately informed the contractor not to use the fuel taken from the Starlifter until further notice. He then informed his superior and consulted the applicable orders to verify the correct procedure to be followed. The orders stated that although the Jet B fuel of the Starlifter was acceptable for use in the Griffon it had to be recirculated and filtered before transfer in order to avoid contamination. Had the contractor proceeded as he planned it would have been necessary to defuel all the Squadron's Griffons and to replace their fuel filters.

Second Lieutenant Gervais demonstrated superior vigilance and initiative in defusing a situation that would have caused substantial delays to flight operations. *Well done!* ◆

Corporal Bruce Wentzell

Shortly after receiving three T58 engine lube filter assemblies from supply, Corporal Wentzell proceeded to disassemble them for further inspection prior to installation. Although this procedure was not mandatory, past experience had shown that engine oil filter wafers have been inadvertently mixed up with forward transmission wafers. During his inspection, Corporal Wentzell noticed that some of the filter screens appeared to be of the wrong size, yet were stamped with the correct part number.

Corporal Wentzell immediately notified his supervisors as he suspected that forward transmission filters had been produced, identified, and delivered by the manufacturer using erroneous engine filter part numbers. He isolated the suspicious filters and then proceeded to check the local supply of wafers where he discovered several others with manufacturing defects. Corporal Wentzell arranged for photographs to be taken and ensured all information was available for transmission to headquarters.

As the result of his professionalism and diligence Corporal Wentzell discovered a very serious manufacturing and quality control problem. Had the misidentified wafers been installed premature failure of the engine bearings may have resulted. *Well done!* ◆

Corporal Leon Hynes

During a periodic inspection on a Hornet aircraft Corporal Hynes noticed that the ECS valves were covered with a red dye. Realizing that the dye resembled that used for fuel tank leak checks, and knowing that there should be none in the area, Corporal Hynes proceeded with an in depth investigation. After an exhaustive survey he noticed what looked like a small crack in the number two fuel cell floor.

The aircraft was sent to the tank bay and NDT was carried out from the inside of the cell. The presence of a three-inch crack was confirmed. Had fuel leaked onto the hot ECS lines, and with no fire extinguishing capabilities in the centre fuselage, the potential for a disaster was very high.

Corporal Hynes' persistence and determination undoubtedly prevented a major occurrence. *Well done!* ◆

Corporal Ed Ferris

During a last chance check on a T-33, Corporal Ferris noticed that the aircraft's right aileron and flap were contacting each other. The condition only occurred with full left control inputs. Corporal Ferris notified the pilot, who felt no abnormalities through the flight controls.

After the aircraft had taxied, Corporal Ferris was still not comfortable with the situation and consulted his supervisor. They then conferred with an airframe specialist and a test pilot. The decision was made to direct the aircraft to return to the ramp prior to take off for further investigation. Subsequent checks revealed an improperly rigged aileron that could have caused serious flight control problems had the aircraft gone airborne.

Corporal Ferris' diligence and thoroughness prevented a possible disaster. *Well done!* ◆

For Professionalism

Corporal Brian McInall & Private Chris Gilson

While retrieving flight line power units, Corporal McInall and Private Gilson noticed a pool of hydraulic fluid near the main landing gear zone on a Silver Star parking spot. The aircraft, which had been there, had recently been dispatched into poor weather conditions for blue water flight operations. Realizing that the implications of their discovery were critical, Corporal McInall and Private Gilson immediately informed their supervisor, and the Silver Star was recalled to the ramp through tower frequency.

When the aircraft was shut down Corporal McInall and Private Gilson's suspicions were confirmed as hydraulic fluid was rapidly being purged from an unserviceable shuttle valve.

Without the quick professional decisions made by Corporal McInall and Private Gilson an aircraft would have departed with a potentially disastrous unserviceability. *Well done!* ◆

Master Corporal Craig Tompkins

During a cargo area inspection Master Corporal Tompkins, a loadmaster with 435 Squadron, noticed a wooden plug handle vibrating loosely on the emergency equipment storage rack. Further inspection revealed six more loose plugs and one plug missing altogether. Master Corporal Tompkins recognized that the missing plug could cause a serious FOD hazard. A Special Inspection was conducted and Master Corporal Tompkins submitted an UCR in which he recommended securing the plug with a screw.

Although Master Corporal Tompkins' original UCR was rejected, and the reinstallation of loose plugs continued using adhesive, he continued to monitor the situation. Further investigation revealed that the adhesive was drying out during normal flight and the plugs continued to pose a FOD hazard. The original UCR was adopted and is being implemented.

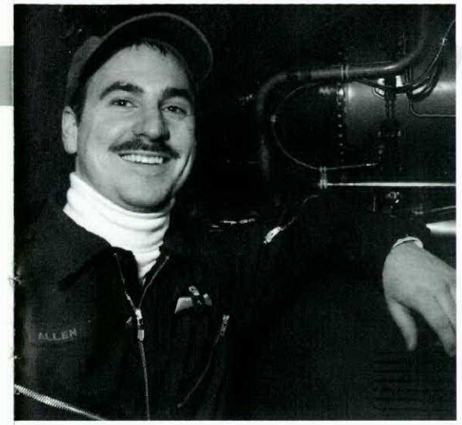
Master Corporal Tompkins' professionalism, perseverance, and attention to detail prevented a potential serious occurrence. *Well done!* ◆

Captain Kevin.E. Morning

Captain Morning, a Griffon pilot at 403 Squadron Gagetown, was walking toward an aircraft when he noticed a piece of darkened metal lying on the ramp.

Captain Morning immediately reported the foreign object, which was then passed to servicing. When it became apparent that the piece was from the " hot end " of an engine, the squadron's aircraft were recalled for inspection. The shard was found to be from the exhaust stack of Griffon 448. Close inspection revealed additional cracking which, had it gone unnoticed, would have resulted in pieces of metal being ejected from the tail rotor possibly causing significant damage to the aircraft and injury to personnel. An exhaust stack of another Griffon was also changed as a precaution.

Captain morning's professionalism, initiative, and attention to detail averted a serious flight safety occurrence. *Well done!* ◆



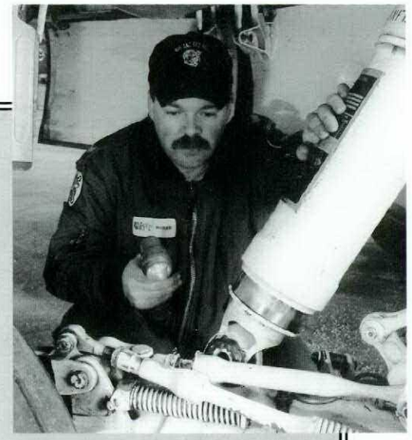
Corporal Rod Allen

During a hot turnaround and crew change of a Griffon helicopter, Corporal Allen initiated a visual inspection of the engine compartments. He ascertained that there was a fuel pressure line leak on the number two engine. Corporal Allen immediately notified the aircraft captain and a shutdown was carried out.

Subsequent maintenance action revealed that the number two fuel pressure line fitting was loose.

Corporal Allen demonstrated a high level of professionalism, initiative, and attention to detail. His actions broke the link in a chain of events that could have lead to a serious incident or accident *Well done!* ◆

Corporal Alain Poirier & Corporal Frank Berger



During a turnaround on a Hornet aircraft Corporal Berger noticed that the cotter pins on a trailing edge flap actuator appeared abnormally loose. Corporal Berger immediately brought the condition to the attention of Corporal Poirier, an experienced AVN technician, who confirmed the abnormality and determined that further investigation was warranted.

Closer inspection of the trailing edge flap actuator assembly revealed that a bushing required to support the main bolt through the trailing edge flap hinge was missing. A considerable amount of damage to the actuator eye end, flap hinge and attaching hardware was also discovered.

There was no visible indication of the problem other than the loose cotter pins. Corporal Berger and Corporal Poirier's keen attention to detail and their meticulous follow up actions highlighted a problem that could have created a catastrophic event. *Well done!* ◆

Corporal Tony Forster

Corporal Forster was tasked to carry out a GPS modification on a Hercules aircraft. The work required the removal of an access panel that is not normally opened. After completing his duty in the area Corporal Forster commenced a FOD check and discovered a small piece of metal approximately one inch long. Concerned about the finding, and although it was not trade related, he inspected every component in the area in an effort to determine the origin of the object. Further investigation by Corporal Forster revealed that the item, and others like it, were rollers from the co-pilot's rudder pedal adjustment arm shaft.

Corporal Forster immediately informed his supervisor of the fault. Upon completion of another inspection it was discovered that only two roller bearings in the assembly had remained intact.

Corporal Forster's professionalism and attention to detail highlighted an unserviceability that if left undetected could have escalated into a very serious flight control malfunction. *Well done!* ◆

Capitaine John Stirton

Au moment de l'incident, le capitaine John Stirton contrôlait le trafic de la piste extérieure à Moose Jaw, où un Tutor s'exerçait à des simulations de situation critique. Après avoir viré en courte étape de base, le pilote stagiaire a demandé d'effectuer un posé-décollé et a confirmé que le train était sorti et verrouillé. Une autorisation d'atterrissage a été accordée, et la reconfirmation de la position du train a été demandée et reçue.

Comme l'avion approchait de la piste et entamait l'arrondi pour se poser, le capitaine Stirton a remarqué que le train d'atterrissage n'était pas sorti. Il a immédiatement communiqué par radio, et le pilote-instructeur qualifié à bord a pris les commandes pour effectuer une remise des gaz. Des entretiens subséquents avec le pilote-instructeur qualifié ont révélé qu'il n'avait pas confirmé que le train était sorti et que le stagiaire avait omis de sortir le train.

Les contrôleurs de la circulation aérienne ne sont pas tenus de vérifier visuellement la configuration d'un appareil à l'atterrissage. Cet effort supplémentaire du capitaine Stirton ainsi que la mesure qu'il a prise ont évité que ne se produise un atterrissage sur le ventre. ◆

Caporal Gary Madore

Le caporal Madore était en train de contrôler un avion Silverstar pour une approche de précision au radar (PAR) lorsque le voyant train gauche non verrouillé s'est allumé en courte finale. Au cours des moments tendus qui ont suivi, le caporal Madore a maîtrisé la situation, assurant la coordination entre les divers organismes et en s'assurant que les personnes visées étaient au courant de la situation de l'avion. Sa suggestion au pilote d'effectuer des approches avec carburant minimal a assuré l'utilisation la plus efficace du carburant limité disponible, ce qui a empêché une urgence de s'aggraver.

La réaction immédiate du caporal Madore à l'urgence de l'appareil, combinée à son attitude calme et assurée pendant les approches subséquentes, a été déterminante à l'heureux dénouement de la situation. ◆

Capitaine Greg Carlow

Alors qu'il évoluait en spectacle aérien dans le cadre du spectacle aérien international de Quinte, le capitaine Carlow, pilote du Snowbird numéro trois du côté intérieur gauche de la formation, a subi un décrochage compresseur et a perdu de la puissance. La perte de puissance s'est produite immédiatement après un passage sur le dos à trois cents pieds au-dessus du sol. Incapable de maintenir sa position au sein de la formation et ressentant une forte vibration, le capitaine Carlow a réduit les gaz au ralenti pour mettre fin au décrochage, et le moteur s'est éteint.

Le capitaine Carlow a rapidement viré à l'écart de la zone où se trouvaient les spectateurs tout en prenant des mesures pour régler le cas du décrochage compresseur et en effectuant les procédures en vue d'un atterrissage forcé. Le moteur a continué à refuser de répondre aux sollicitations du pilote, et le capitaine Carlow a alors exécuté un atterrissage forcé impeccable.

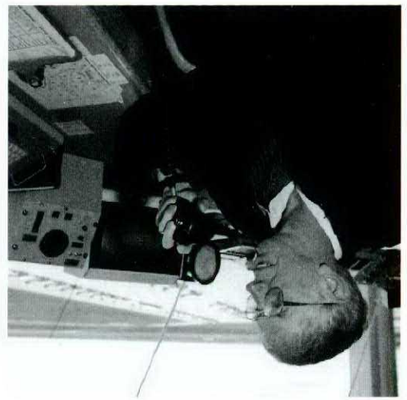
Les mesures immédiates et appropriées du capitaine Carlow dans des circonstances extrêmement difficiles ont permis d'éviter de perdre une ressource aéronautique précieuse tout en assurant la sécurité des spectateurs présents. ◆

Captain John Stirton

At the time of the incident Captain Stirton was controlling traffic on the outer runway at Moose Jaw on which a Tutor was conducting simulated emergencies. Upon turning a short base leg, the student pilot requested a touch and go landing and confirmed that the gear was down and locked. Landing clearance was given with a reconfirmation of the landing gear position requested and received.

As the aircraft approached the runway and commenced the roundout for landing Captain Stirton observed that the landing gear was not down. Captain Stirton made an immediate radio transmission and the QFI on board took control and conducted an overshoot. Subsequent discussion with the QFI revealed that he had not verified the landing gear down confirmation and that the student had failed to select the gear down.

Air traffic controllers have no requirement to visually verify the landing configuration of an aircraft. Captain Stirton's extra effort and action prevented a wheels-up landing. *Well done!* ◆



Corporal Gary Madore

Corporal Madore was controlling a Silverstar aircraft on a PAR approach when it experienced an unsafe left main landing gear indication on short final. During the tense moments that followed, Corporal Madore maintained control of the situation, coordinating between the various agencies and ensuring all personnel involved were aware of the status of the aircraft. His suggestion to conduct "min fuel" approaches assured the most efficient use of the limited fuel available, thus preventing the emergency from deteriorating into an even worse situation.

Corporal Madore's immediate response to the aircraft emergency, combined with his calm, controlled manner during the subsequent approaches, played a key role in assuring the timely and successful resolution of the situation. *Well done!* ◆

Captain Greg Carlow

While performing at the Quinte International Airshow Captain Carlow, the Snowbird number three inner left wing pilot, experienced a compressor stall and a loss of thrust. The power loss occurred immediately following an inverted pass at three hundred feet above ground level. Unable to maintain position in the formation and detecting a strong vibration, Captain Carlow reduced the throttle to idle to clear the stall at which time the engine flamed out.

Captain Carlow quickly turned away from the spectator viewing area while simultaneously performing compressor stall clearing and forced landing procedures. The power plant continued to refuse to respond and Captain Carlow executed a flawless forced landing.

Captain Carlow's correct and immediate actions under extremely difficult circumstances prevented the loss of a valuable aviation resource while also ensuring the safety of the spectators in attendance. *Well done!* ◆