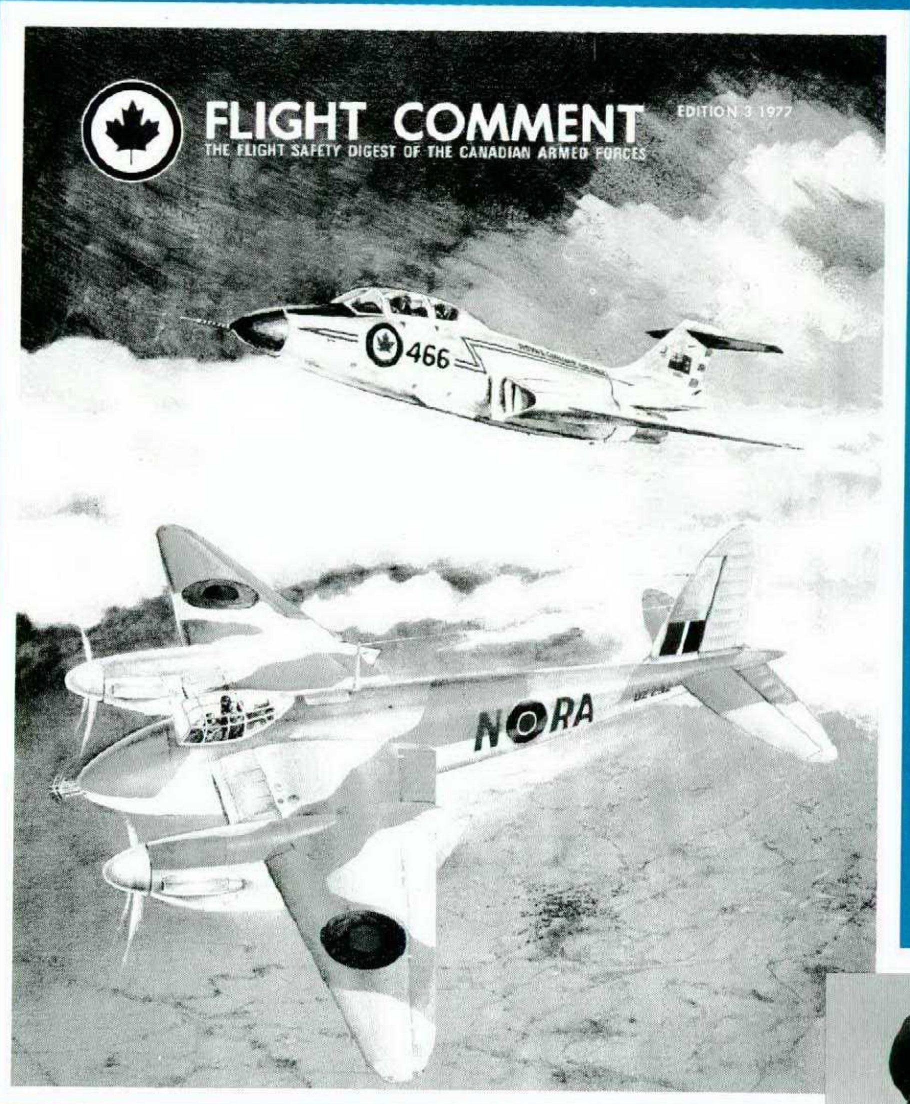
FLIGHT COMMENT

EDITION 3 1977

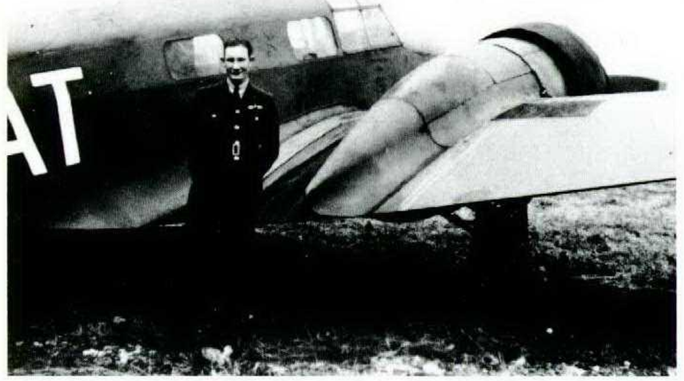
THE FLIGHT SAFETY DIGEST OF THE CANADIAN ARMED FORCES



COLONEL R. D. SCHULTZ

Colonel R.D. Schultz, the Director of Flight Safety of the Canadian Armed Forces and the pilot of the night fighter involved in 1943 in what was later termed "the outstanding night fighter mission of World War Two" will go on retirement leave in late August of this year after 36 years of service.

Colonel Schultz, a native of Bashaw, Alberta, joined the RCAF in July 1941, with the rank of Aircraftsman 2nd Class. After elementary training on Tiger Moths at Sea Island and Service Flying Training on Ansons in McLeod, Alberta he was awarded his wings and transferred as a Sergeant Pilot to England. In August 1942, after advanced flying training on Airspeed Oxfords he was selected for night fighter training and transferred to Charter Hall in Scotland for operational training which was carried out on Bristol Blenheims, Beauforts and Beaufighters.



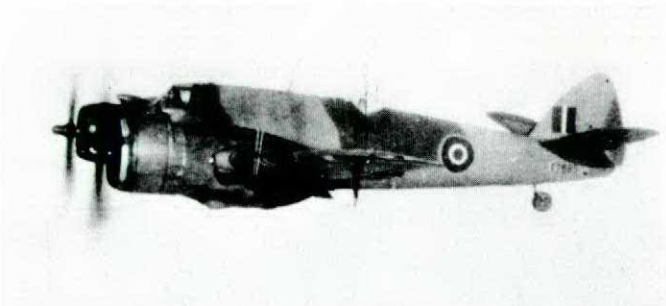
Airspeed Oxford aircraft at RAF Brize Norton, Oxfordshire in June 1942. Colonel Schultz was then a Sergeant Pilot attending #2 Pilots Advanced Flying Unit.

The Bristol Beaufighter MkII Aircraft which was flown at 54 OTU Charter Hall.

By December 1942, Sgt Schultz was "combat ready" and was transferred to 410 Squadron RCAF which by then was active in Britain flying Beaufighters initially and later Mosquitoes. The squadron flew night fighter patrols, night intruder/bomber missions, and carried out its share of training missions as well.

It was as a Pilot Officer that R.D. Schultz and his navigator F/O V. Williams reported this action in August 1943.

"During a night patrol over France, we bombed a railway bridge near Clermont and attacked and damaged three locomotives and three goods cars. On the return journey we climbed to 6,000 feet and saw an aircraft which began to move into close formation on our right wing. The aircraft, which we recognized as a Do 217 closed into about two wingspans range apparently mistaking us for a friend. Suddenly he recognized his error and broke hard right in an effort to get out of this ludicrous situation. We broke right and followed him, quickly re arming our cannon which we had previously safetied. The enemy aircraft opened fire accurately from the under turret. We closed in on him while he took evasive action and eventually we opened fire at 400 yards. The enemy aircraft dived underneath to port and we closed in to 150 yards, the enemy aircraft took further evasive action, carrying out a skidding turn at right angles. A half second burst was fired from 150 yards. Strikes were observed in the cockpit area where fires broke out, and burning pieces were seen to drop off the enemy aircraft. Very inaccurate return fire was observed. Immediately afterwards four of the crew baled out. The enemy aircraft then went into a shallow dive in the direction of the French coast. We closed in to 50 yards and gave another half second burst. The starboard wing and engine fell off the enemy aircraft. It exploded, was completely enveloped in flames, and went into the sea.



Bristol Beaufighter

Pilot Officer Schultz and two of his groundcrew in front of their Mosquito MkII "O for Orange" - the last of the all lampblack painted Mossies in service with 410.

Later, on the night of 10/11 December 1943, Schultz and his navigator took off on what was to prove their most fruitful single mission. An edited transcript of the mission report reads"

"A Mosquito II aircraft with F/O R.D. Schultz pilot and F/O V.A. Williams observer – both Canadian, left Hunsdon at 1800 hours 10th December, 1943, for defensive patrol under Trimley Heath G.C.I. The Mosquito patrolled North to South midway across the North Sea at 15,000 feet for about 50 minutes. The pilot was then given a vector of 070 degrees and told to investigate a bogey with caution – three minutes later being told to climb to 20,000 feet. Vector was then changed to 010 degrees and bogey was said to be six miles dead ahead. The observer immediately obtained contact slightly to starboard and well below – range 14,000 feet. The Mosquito dived rapidly and overshot. The pilot asked for further help and was given a vector of 240 degrees obtaining contact again at 14,000 feet dead ahead. This range was closed very rapidly and visual contact obtained at 6,000 feet on an aircraft coming head-on at a height of 14,000 feet. The Mosquito swung round and got on its tail, momentarily losing visual contact, but the observer held radar contact and visual contact was picked up again at 7,000 feet dead astern. The Mosquito closed in and no recognition signs were seen nor was the target showing IFF. Schultz closed in rapidly to 50 yards but the enemy aircraft, by then recognized as a Do 217, fired a long accurate burst before he could open fire. The target peeled off to port. The Mosquito followed and got in a short burst which set the starboard engine on fire. The target continued evasive action losing height rapidly and at 9,000 feet a long burst was fired by Schultz which resulted in a large flash and explosion on the starboard side of the 217. All return fire had ceased by now, but the enemy pilot kept up evasion trying to gain cloud cover at 7,000 feet. Unfortunately for him he went straight through it. The Mosquito followed and at 1,500 feet the target steadied up, opened its bomb doors and apparently tried unsuccessfully to jettison its bombs. After another long burst from quarter astern the target hit the sea burning furiously. Cine camera shots were taken of wreckage.

The Mosquito was then given orders to climb as fast as possible to 15,000 feet. On reaching this altitude it was given a vector of 010 degrees and a distance of three miles. Again the observer got contact at once at 14,000 feet range and the Mosquito closed in very rapidly. Visual contact was obtained at 7,000 feet and the target identified as another Do 217. One burst was fired from dead astern opening fire at 300 yards. At 50 feet range the target blew up and the Mosquito flew through the debris. No evasive action or return fire was observed and it would appear that the target's bombs blew up as the Mosquito crew felt a considerable jar when the Dornier exploded.

Just after passing through the debris, the observer who had been holding another contact during the last engagement, told the pilot to turn starboard 10 degrees 7,000 feet range and pilot obtained visual contact at once at height of 12,000 feet. The Mosquito closed in rapidly, identifying another Do 217. Now began a long duel, with the enemy pilot performing exceptionally skillful evasive manoeuvres.

Schultz fired two very short bursts from astern, but missed. The enemy aircraft peeled off to port and fired a very accurate burst from its dorsal position. The Mosquito followed the target down to 9,000 feet and the pilot fired a long burst which set fire to the enemy's starboard engine. Evasive action went on down to sea level and the enemy aircraft turned for home. This was a fatal tactical error for the enemy pilot stopped evasion for this short period enabling Schultz to get in another short burst, causing the starboard engine to blaze. The target put out a defensive barrage from every available gun, the Mosquito was hit in the nose, a cannon shell smashing the instrument panel and missing the pilot by three inches. One more burst at the target caused the port engine to catch fire. The enemy pilot kept going with both engines burning but eventually dove into the sea.

The starboard engine of the Mosquito started to sputter and the pilot was about to feather it when the port engine caught fire. The starboard engine picked up after the port had been feathered, and the fire extinguished. The pilot gave a preliminary "Mayday" warning which he cancelled and managed to land at Bradwell on one engine at 19.45 hours. During the journey to Bradwell he had no temperature gauges to consult as these had been shot away.

During the three combats the Mosquito performed extremely well even after being severely damaged, the remaining engine functioned perfectly to get the crew back to Bradwell.

Schultz remained with 410 Squadron for two and one half years and accumulated some 800 hours of flight time, five aircraft destroyed and his first Distinguished Flying Cross before being posted to the Night Fighter OTU at Charter Hall as an instructor. He served there and later at Cranfield as an instructor and test pilot until December 1944 when he rejoined 410 Squadron now flying from Lille, France with 147 Wing of the Second Tactical Air Force.

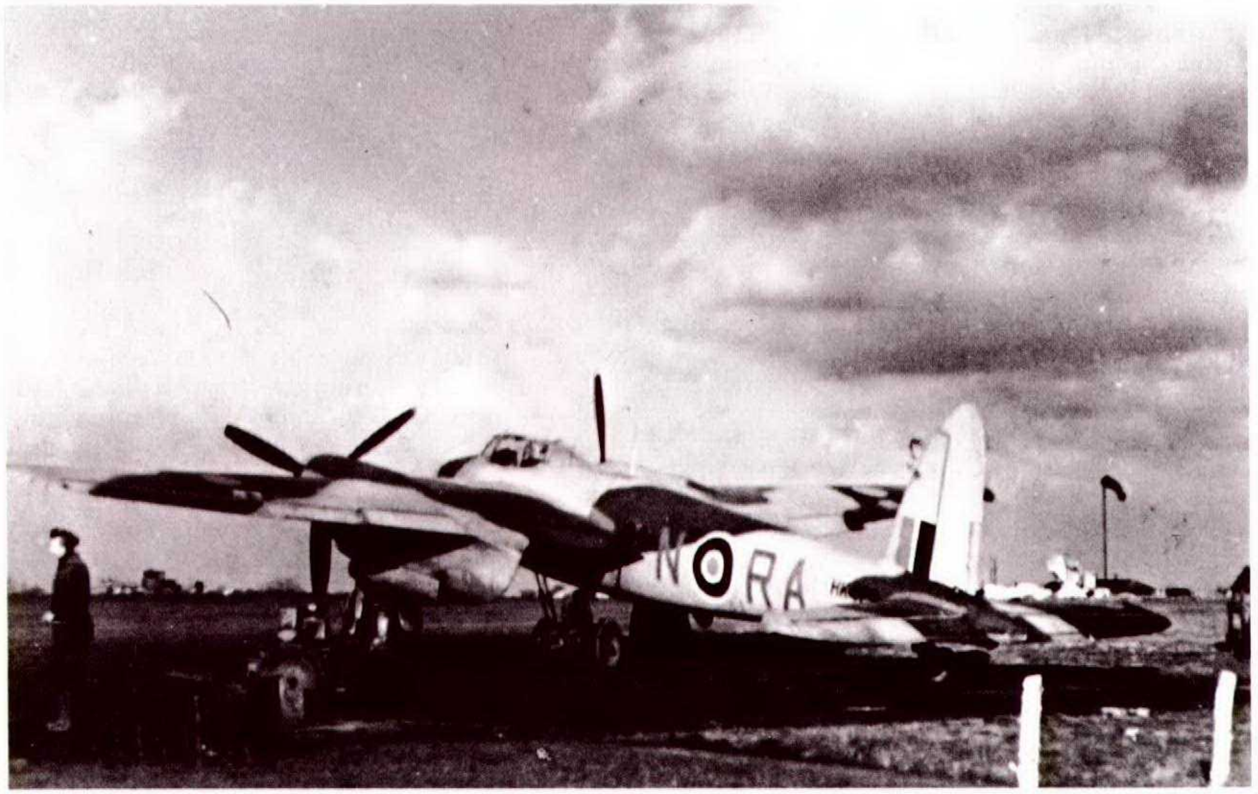
The war ended for then Flight Lieutenant Joe Schultz with 410 Squadron stationed in Gilze Rijen, still equipped with the Mosquito. In late May 1945, F/L Schultz was awarded a bar to his DFC for destroying a further three enemy aircraft in the final stages of the war in Europe.

Deciding to remain in the peacetime RCAF Flight Lieutenant Schultz found himself employed as a test and ferry pilot flying out of St Hubert, Rockcliffe, Toronto, and Trenton. It was during this period that his logbook was certified for no less than thirty-two aircraft including types as diverse as the Tiger Moth and Lancaster, the Spitfire and the Grumman Goose. Perhaps this was a portent of what was to come, for Colonel Schultz as of this date has flown most of the aircraft types currently in service.

In December 1948, Flying Officer Schultz (officers reverted in rank after the war) was posted to the Vampire OTU and then was posted to none other than 410 Squadron, his wartime unit which had by then become the first jet fighter squadron in the RCAF. He was a member of the RCAFs first jet aerobatic team the Air Defence Group "Blue Devils" and flew in air displays across the North American continent before being posted to the RAF Central Fighter Establishment on exchange. Here he added to his already impressive credentials by flying Meteors, Venoms and Vampires which prepared him for his return to Canada to the position of Chief Flying Instructor at our newly formed 3 All Weather OTU at North Bay – the training mill for our burgeoning force of CF100 squadrons.

Since that time his responsibilities have grown with each successive appointment, including Staff Officer Air Operations at Air Defence Command Headquarters, Squadron Commander of two CF100 Squadrons, 413 and 432, Squadron Commander of 425AW(F) Squadron the first Canadian CF101 Voodoo Squadron, Chief Operations Officer at No. 4 Wing during the early years of the CF104 operation in Europe, and in 1966, Head of the Aircraft Accident Investigation and Pre-

December II 1942, the morning after the historic three victory mission, Schultz (centre) describes part of the action for his navigator F/O V.A. Williams (left) and Flight Officer Dick Geary USAAF at RAF Hunsdon.



"N for Nan" the registration symbol for the aircraft in which Schultz scored the majority of his eight victories.

On return to St Hubert from Exercise Sweetbriar in February 1949, Schultz, Flying Officer (now BGen) Bill Paisley, and Flying Officer Don Morrison now chief pilot for International Nickel gather in front of a squadron Vampire for a brief discussion.

vention section of the Directorate of Flight Safety and eventually his appointment as Director in 1967.

In his position as Squadron Commander of the first Canadian CF101 Voodoo Squadron, Col Schultz was responsible for the conversion training of all aircrew who were to man all the other Voodoo squadrons. In this appointment he held a key post in the development of our nuclear capable air-to-air interceptor operations. Col Schultz is considered largely responsible for the highly successful introduction of the CF101 Voodoo into the RCAF.

Later, as Chief Operations Officer at No. 4 Wing in Europe Col Schultz's knowledge, dedication and meticulous attention to detail were of inestimable value in establishing a first rate nuclear strike operation. This was evidenced clearly by the unit being given a very high rating on its initial NATO Tactical Evaluation. A unique achievement and one which earned for Canadians the admiration of all their NATO partners.

Col Schultz has been Director of Flight Safety for the Canadian Forces for the past ten years. In this appointment he has been manager of one of the most highly regarded Flight Safety programs in the Western World. During his tenure the accident rate, one important indicator of the effectiveness of any accident prevention program, reached an all time low for the RCAF/CF of less than one per 10,000 flying hours. Much of the credit for this outstanding achievement must be attributed to Col Schultz's unfailing devotion to duty. He has conducted an active accident prevention program based on his firm conviction that operational effectiveness, the primary objective, depends on a sound accident prevention program.

In spite of budget limitations Col Schultz has persevered with such programs as Crash Position Indicators and Flight Data Recorders and "Bird Hazards to Aircraft", to the point where Canada has become a world leader in these fields. His tireless efforts to conserve aviation resources through an effective accident prevention program have won him the respect of subordinates and superiors alike. His infectious and unwavering enthusiasm has been an inspiration to all those tasked with flight safety responsibilities. Many of his former staff officers are now in responsible positions with the Department of Transport Aviation Safety and Aircraft Accident Investigation Divisions.

Col Schultz is highly respected in both Canadian aviation circles and internationally for he has often represented Canada in international seminars dealing with broad concepts of air-

CF100 Mk 5 Aircraft provides the backdrop as Squadron Leader Schultz, now commanding 413 Squadron poses with navigator S/L (later Group Captain) Bill Hanson.

At the very beginning of the 101 program Colonel Schultz is shown having just completed his combat ready check at Hamilton AFB California. Also pictured is his navigator on this mission Major John Bradley RCAF (retired).

craft accident prevention. Although it is impossible to estimate the numbers of aircraft and lives saved by his dedicated efforts, we are convinced that through his devotion to duty, the standards of all those involved in the operation of Canadian military aircraft have been raised substantially.

The Canadian Forces and Canada have every reason to be justifiably proud of Col Schultz. Our flight safety program is primarily the result of his continuing hard work, self-sacrifice and dedication in furthering the cause of military aviation. In recognition of his many postwar contributions to the Canadian Forces Col Schultz was named an Officer of the Order of Military Merit in 1974.

breaking the ice

by Maj Harv Haakonson NDHQ/DPM

He was young. They are all at first. But if his youth had not betrayed him his inexperience it would still have been reflected in the shiny new wings on his left breast. His apprehension was obvious as he opened the flight room door and surveyed the unfamiliar surroundings. He glanced nervously from face-to-face desperately hoping to find a familiar one . . . or at least one reflecting some evidence of recognition. As the silence stretched into eternity his thoughts darted back to the security of his office and the patients he had left there. Had he not already come through the door, it would have been so much easier just to return to that den of seclusion. He might have turned and fled anyway if, at that moment, Tom had not appeared through the back door of the flight room.

"Hi Doc! Glad to see you could make it. Sorry I couldn't get by the office to pick you up."

"Hi Tom. Thats okay."

"Come on Doc, I want you to meet the guys in the squadron."

And as quickly as it had come the fear fled. Led by Tom he moved more comfortably through the flight room meeting one crew member after another. What a difference a friend makes!

He hadn't really wanted to do the Flight Surgeons' Course in the first place . . . after all, he had just finished his medicine and he was anxious to get on with the business of practicing it . . . he didn't really want to go right back on course. However, now that it was over he did have a responsibility to the aircrew, and he would do his best to carry it out. He was thankful that Tom, the Flight Safety Officer, had come to see him as soon as he got back from the Flight Surgeons' Course. Otherwise, it would have been even more difficult to drag himself away from the security of the hospital to face the unfamiliarity of the flight room. Certainly, if Tom hadn't arranged it, he would never be here this morning to be presenting a lecture to the aircrew.

Perhaps now that he had met some of the squadron members it would be easier to come over on his own. He was looking forward to learning more about the operation of the squadron, and he was certainly looking forward to the flight that Tom had arranged for him that afternoon.

As they wandered down the hall from the flight room, his thoughts wandered back to the Flight Surgeons' Course and the lecture which had discussed the relationship between the Flight Surgeon and the Flight Safety Officer. He hadn't really appreciated its significance at the time, but right now he was acutely aware of the importance of his alliance with Tom. Tom was already arranging a series of familiarization visits to servicing, maintenance, the Met Office and the Control Tower. He also knew that Tom had a keen eye for all of the potential Flight Safety Hazards, and would be very willing to help him deal with those of an aeromedical nature. Yes, getting to know the operation was going to be much easier with Tom's help — and so his effectiveness as a Flight Surgeon was going to be maximal. He and Tom would see to that.

He entered the briefing room with a smile of reassurance on his face . . .

Decisions and Decision Height

You're flying a precision approach in really bad weather. If you arrive at the decision height (DH), see the runway, and are otherwise set up for a safe landing, you then make the decision to land. Right? That's true as far as it goes.

I was reading an accident report about an air carrier pilot who did all of the above but ended up banging up his aircraft, some ground equipment, and a few passengers. There were a lot of factors that made this accident likely, but one really caught my interest after thinking about it. At DH, the pilot had the runway in sight. He did all the usual stuff: transitioned to visual references, picked up the VASIs, etc. The problem was that a heavy rain shower drifted across final approach and, once again, he was in IMC.

You and I know that this sort of thing can happen. Rain showers, thin fog, and all sorts of bad things can obscure the runway environment after we've once located it. We also know that the only salvation is performing an immediate missed-approach. The pilot in this accident added power but did not increase the aircraft's angle of attack sufficiently to arrest his rate of descent. He did not execute a missed-approach. By this time, his thoughts were interrupted by strange sounds coming from the bottom of the aircraft. There just wasn't enough time to think things over.

The thing that scares me about this accident is that I can see it happening to me, especially at night when that rain shower or whatever, may not be visible. When I break out of a low ceiling and see the runway, I'm thinking glide path, runway alignment and condition, configuration, airspeed, winds — all things related to landing. With this frame of mind, that last minute missed-approach necessitated by an unexpected weather problem may not be initiated as quickly as necessary.

Maybe this airline pilot's misfortune can teach us a lesson. The last big decision may not be at decision height. A later decision may have to be made. Considering the time available to make that decision on short final, perhaps we should make it before the approach, leaving only reaction time to delay our missed-approach.

an exchange officer speaks out

by Lt Cdr David A. Raines

As an exchange officer I have often felt that the exchange of ideas remains either at unit level or gets lost in the labyrinth of NDHQ/MOD when terminal reports are written. Consequently I have decided to put pen to paper and use Flight Comment as a vehicle to record my comments on the differences between rotary wing flying in Maritime Command and the Fleet Air Arm. All of my Canadian flying has been in the Sea King helicopter but most of my observations are intended to interest all professional aviators.

GENERALLY

As a naval aviator my first impressions are that we all suffer from the same frustrations both at sea and ashore with aircraft unserviceability, ships not in the correct rendezvous position, apparently crazy decisions from the Command who have the "big" picture, ad infinitum and when all around you turns to rodent manure it seems that keeping ones cool and counting up to ten works just as well whether you are paid in dollars or pounds sterling.

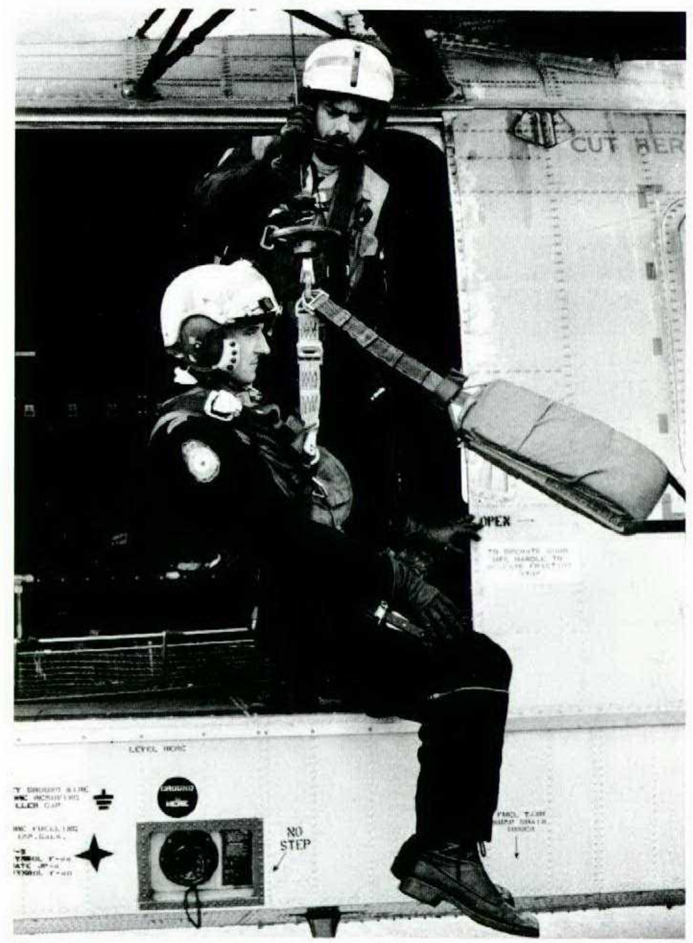
To move to pounds weight I think that the average Canadian serviceman is undoubtedly more rotund than his Kipper counterpart, but I am most impressed with the great emphasis placed on physical fitness and the way in which a large percentage of my Squadron voluntarily take advantage of the recreational facilities. While thinking of fitness, smoking springs to mind – particularly in operational aircraft. No smoking is allowed in any Royal Navy aircraft and I still feel unsettled as the rest of my crew merrily puff away sitting on 4,000 lbs of fuel and surrounded by hydraulic lines at nearly 3,000 P.S.I.

I also feel unsettled by the numerous loose articles regularly carried in the aircraft. They range from "innocent" helmet bags hanging on the back of seats to the mélange of blade cuffs, engine intake blanks and tail fold bars carried "just in case we divert". When carrying passengers it is not standard practice to tie baggage down and hanging wardrobes swing lazily from longitudinal frames. Having been inside both real and simulated helicopters which were submerged and inverted I consider even an "inocent" helmet bag to be a hazard when seraching for an escape route. Perhaps the twin engined Sea King with its good amphibious capabilities has seduced us into a false sense of security.

In its secondary role of Search and Rescue the Sea King is not a well equipped vehicle. Essentially one must carry equipment that ANYONE can use ANYWHERE at ANYTIME. The Billy Pugh rescue net does not fall into this category as it requires a high degree of skill to achieve successful pick ups and constant practice to maintain that standard. As a diver who has suffered near decapitations and submerged draggings I feel less than confident in the Billy Pugh to recover me when injured and frightened in the North Atlantic. When picking up survivors from the water one must always assume that even if not injured they are shocked and require the assistance of a crewman. It is possible to lower a crewman with the Billy Pugh in reasonable conditions (or a ship's diver in adverse conditions) but he would not be attached to the aircraft and so could easily become another casualty, hence compounding the problem.

The double lift harness would solve this problem. When suspended on the hoist wire in this harness the crewman is in a sitting position able to steer himself in the water approaching a survivor and has his hands free to put the horse collar on the casualty. (See photograph A). On the way up the survivor can be reassured and at the doorway be easily pushed back into the cabin. With a Stokes litter the double lift technique is equally valuable allowing the crewman to hold passive during the hoist and again steer the litter into the cabin. When the harness is being used for lowering the crewman over land or onto a pitching ship it allows the crewman to look for dangerous obstructions and use his hands to fend off (See photograph A). It is a simple and light piece of equipment that can be used ANYWHERE at ANYTIME by ANYONE. Equally simple and light, though not quite as comfortable, is the Canadian Armed Forces rescue specialist harness which achieves the same result. (See photograph B). As this is a stock item "on the shelf" I suggest the Billy Pugh be removed from the aircraft and replaced by the CAF Harness immediately.

British double lift harness and horse collar.



Canadian rescue specialist harness being used on the CH124A rescue hoist.

One small difference between our horse collars is that the webbing of the British version is totally enveloped in rubber whereas the Canadian version has rubber only on one side which is narrower than the webbing. I find that this sharp edge of webbing cuts into the arm pits and actually hurts if the hoist is stopped. RN helicopters also carry an extra large horse collar after experiencing problems during the rescue of a large fat seaman wearing a bulky merchant life jacket. The present SAR equipment is stuffed under and behind a seat with no proper stowage thereby becoming a loose article hazard. The problem can be solved with a locally produced SAR bag which is pinned to the aircraft bulkhead and has custom sized pockets to stow each piece of equipment. One pocket in the RN aircraft contains chalk (in a tin to avoid FOD) and a chalkboard which proves useful to pass instructions to fishing boats, survivors or even warships with radio problems.

SAFETY EQUIPMENT

We all wear the same immersion suit but I was surprised to discover that the Canadian poopy suit is not wired for 28 volt electrical heating to combat the extremes of winter. I do not like the physical or aural protection offered by my helmet although the change from a "hot" throat microphone to a "cold" boom microphone is a relief after sharing the intimacies of gulping coffee and coughing with a British crew. However, I do miss my throat microphone when hoisting because to fit a suppression cut with its two press studs and different electrical plug requires me to remove my helmet in flight or ask my crewman to fit it.

My Canadian Mae West is one of the worst snagging hazards I have ever encountered and I am sure it would impede an underwater escape from an aircraft. The three separate inflation chambers are a good feature but in the water I find it uncomfortable to the point of being painful and even the excellent strobe light cannot replace the personal SAR Beacon on Guard which clips on the lobe of the Kipper Mae West.

If you have ever seen Kipper aircrew walking to the aircraft like to hunch back of Notre Dame you will appreciate why I enjoy wearing the Canadian dinghy, particularly as it has a lumbar support bladder which can be inflated to ones own requirement. Equally comfortable is the shaped headrest which allows one to put ones head back with out getting a cranial massage from helmet/airframe contact. In conclusion on Safety Equipment I have one small but relatively important flight safety point which came to light in the Puerto Rican areas. Now that fixed rotor flying from the aircraft carrier has ceased there are no long sleeved lightweight flight deck jerseys in stores and there is a tendency for ground and flight deck crews to wear the green working shirt with an open neck and the sleeves rolled up. While this problem can, and is, solved locally even the staff in NDHQ must wear the correct and safe clothing for the job particularly when it gets hot.

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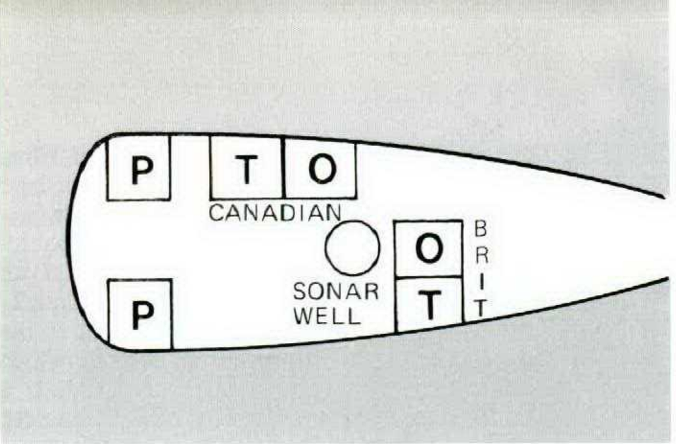


Sea King backseat layout

SEA KING AIRCRAFT

If I might be a little parochial, the first obvious difference between the RN Sea King HAS I and the Canadian CH124A is the back seat layout.

While the back seat crew positions are relatively quieter in the CH124A the sonar operator is poorly placed for easy underwater escape and must be agoraphobic to enjoy sitting where he does. The seats were obviously not designed for pilots because there are more than two levers! With the eight levers available the TACCO and sonar operator can produce any number of permutations to scrape each others legs and block access to both normal and emergency routes within the aircraft. Having worked through pools of Kipper hydraulic fluid I am impressed by the cleanliness of the Canadian Sea King and all RN Air Engineer officers would kneel and worship the sonar reeling machine cover which efficiently excludes all salt water from inside the airframe.

Deck procedures in Maritime Command have impressed me particularly as only one person, the LSO, is exposed to any immediate danger during the take off and landing. Much of this stems from the excellent helicopter haul down and rapid securing device affectionately known as Beartrap. I have landed in helicopter destroyers (DDH) on many occasions when an RN Sea King would have been completely out of limits as they are only capable of free deck landings. I look forward to seeing how the Beartrap compares with the British Lynx Harpoon system.

Having come from an instructional job in the British Sea King Simulator I am well aware of the value of flight simulator training. However, the degree of valuable training achieved depends largely on the psychological approach which includes carrying out a formal briefing, wearing correct flight clothing, flying the whole sortie realistically and ensuring that controlling staff only act as legitimate outside agencies and do not give unrealistic aid which would not be available during normal flight. When the new Ferranti software package is fitted in the Sea King Simulator at Shearwater it will be relatively simple to achieve these aims and standardise all Sea King flying in the CAF.

One procedure which cannot be simulated totally is a water landing. VT 406 runs a Waterbird Course which to say the least is invaluable. Obviously the prime value is for pilots but I sugest it is also valuable for boosting the back seat crews confidence in the Sea King's amphibious capability, particularly for single engine failures in the hover. As a TACCO in the RN I fly as a Crew Commander and the Waterbird training has certainly given me more confidence to make both personal and crew decisions should my aircraft land on the water.

My comments and observations have praised and criticised a system which most readers have come to accept as the norm but I have tried to be honest in an attempt to show the one major lesson I have learnt during my first year on exchange. There is always more than one way of tackling a problem. Where professionalism is concerned it is imperative to keep an open mind.

the author

Lieutenant Commander Raines joined the Royal Navy in 1964 as a cadet at the Britannia RN College. He served initially as a ships officer and in this role visited Singapore, Hong Kong, Australia, Malaysia and Borneo and qualified as a Ships Diving Officer.

In 1969 he commenced training as a navigator, and in this role he has served in the carriers HMS Eagle and HMS Ark Royal and instructed at the RN Observer School. He has flown in eleven different aircraft types in the past eight years and while stationed in Halifax on exchange has served with HS 443 both ashore and embarked in HMSC Assiniboine and HMSC Huron.

ACCIDENT INCIDENT

The photographs submitted with accidents and incidents, investigation reports, and proceedings of courts of inquiry are consistently below standard. The average accident will strain the capabilities of any base photographic section, and some photographers have been known to break down and cry when they see a safety officer approaching.

At some accident sites the photographer spends a day or so following each board member around the wreckage and snapping a picture, maybe two, every time the board member points his finger. After the photographer runs out of film or daylight he tries to get someone to fill out a work order and tell him what they want done with all those magic moments he captured on film. Someone makes a wild guess on the probable number of prints required and says something like "Oh, give us twenty 8" X 10" glossies of everything that you shot."

A few days later the board realizes exactly what a stack of 1,200 or more photographs looks like. *It looks like a mess.* Worse, the board now discovers that some of the prints were duplicates, some can't be identified, and the rest aren't the best possible enlargements. It's then too late: they have to make do with what they have.

A few simple ground rules on accident/incident investigation photography can save everyone a lot of time, money and frustration.

Supervise the Photographer. Assign one person, usually the BFSO, or someone who has been BFSO-trained, to monitor all photography and to effect liaison between members of the investigating team. This way, the photographer knows exactly who he is working for, and the liaison officer knows what has already been photographed. At present, most photographers are taught very little about crash photography and have had little practical experience at crash sites. Most importantly, the photographer must be instructed not to move pieces of wreckage to obtain better shots. Pointing at something is not good enough. The supervising officer must accurately describe the shot for the photographer and show him exactly what needs to be in focus.

Identify the Pictures as They are Taken. Everyone tries to do this but the success rate is pretty low. The supervising officer should accompany the photographer with a paper sheet with lines numbered 1 to 36. The number of the film roll being shot should be entered at the top of the page. Then, as each shot is taken details of the subject covered should be written on the sheet before they are forgotten.

Speed is Essential – but Safety First. Because of the time of day or inaccessibility of the wreckage it may seem desirable to defer photography to a more convenient time. However, it is possible that storms, high winds or fire occurring during the intervening period may damage or destroy vital evidence. Where practical, therefore, photographs of the wreckage should be taken as soon as it is safe to do so. Close-up photographs of failed components are best taken in the studio under controlled lighting conditions.

"Overshoot but Underprint". Photography is the best way to document an accident and photographs are an invaluable aid to investigation. Film is relatively cheap, but enlargements are expensive and time-consuming. As a rule, don't order enlargements until you've examined the negatives or, preferably, contact prints. These can be made available in a matter of hours. From the contact prints, select the photograph you want printed, determine cropping with the aid of the photographer if necessary, and provide captions from the notes you made at the crash site. Prints should be a standard 5" X 7". This size has been found to be the most convenient for appending to reports and for reproduction in DFS publications.

Type of Film. Prints of accident photographs appended to reports should normally be black and white. It is essential, however, that a 35mm colour transparency coverage should also be provided. (Only colour photography can provide an accurate record of visual contrast of point of impact between two surfaces painted with different coloured paint, etc.)

Furthermore, transparencies are filed in the DFS accident film library and are used during courses and lectures to professional bodies. Again, accurate documentation of transparencies is essential and a list describing the subject should be forwarded with each set.

Roger... we've got it

Shortly after a night takeoff, the backseat instructor pilot lost his interphone and UHF radio. Unable to regain communication with either the outside world or his student, he shook the stick and began a turn to position himself on downwind for a radio-out pattern. The front-seat student recognized the IP's control inputs, but missed the stick-shaking signal; so he continued on the stick with his instructor.

While maneuvering to downwind, the IP felt the student on the controls and shook the stick again. The student acknowledged the change of control verbally, an unproductive procedure under the circumstances, and then shook the stick again. Feeling the IP shake the stick yet again, the student assumed that he was to take control and attempted to do so.

By now, each pilot thought that he was controlling the aircraft, and that the other's inputs were control malfunctions. As the double pilot-induced oscillations became progressively wilder, the IP decided that a loss of control was imminent. He ejected safely, followed immediately by his student.

GOOD SHOW

WO F.E. BROTHERS

During the spring of 1976, 419 Squadron experienced a series of compressor stalls induced by damaged compressors. Thorough investigations were carried out but the FOD source remained unidentified although it had been identified as a small metal object. These incidents had averaged approximately one per month until May, when several occurred in rapid succession thus creating a critical flight safety problem.

Almost simultaneously WO Brothers, the 419 Squadron Snag Recovery WO was informed by squadron weapons personnel that they had been finding breakage of the 20 MM link striker tabs after gun firing operations. These small tabs had been known to break in the past but not at the frequency which was now being experienced. WO Brothers obtained a broken tab and discovered that it fit precisely into the damaged area of a recently fodded compressor. He did a survey of the squadron CF-5A gun bays and discovered that these compartments were extensively contaminated with broken tabs. He investigated further and determined that there were several ways in which these broken tabs could exit this compartment for possible ingestion by the engines in flight. WO Brothers brought this information to his superiors and all gun firing was suspended pending a solution. All CF-5A's were grounded until the gun bays were thoroughly purged of broken tabs.

These broken tabs were eventually verified as the previously unidentified FOD source when the Base Engine Bay discovered one embedded in a compressor blade on an engine strip down. The ammo links from which these tabs were breaking were also eventually found to be substandard. All gun bay compartments were cleaned, a major modification was called up, sealing the compartment to prevent inadvertent exit of any broken tabs and the squadron resumed firing.

Warrant Officer Brothers is commended for his initiative combined with a high standard of knowledge which made it possible for him to correlate the facts and solve a critical FOD problem, indeed an outstanding contribution to flight safety.

CAPT M.M. HARDIE

During a Voodoo formation take off while flying as number two, with two full external tanks fitted, Capt Hardie experienced thick smoke and acrid fumes in the cockpit at nose wheel rotation speed of 155 KIAS.

The smoke and fumes caused limited visibility, burning, and watering to the eyes of the pilot. A quick decision to abort the take off was made and while carrying out the abort, Capt Hardie decided to shut one engine down in an attempt to lessen the volume of smoke and fumes.

The arrestor hook was lowered but not required as the aircraft was stopped in 8,000 feet. Both aircrew members carried out an expeditious ground egress and ran from their smoking aircraft.

The prompt response and correct handling of this emergency averted possible catastrophic consequences had the aircraft become airborne.

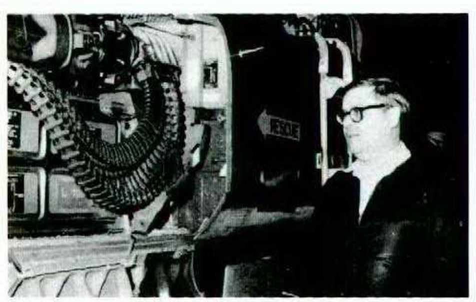
Considering the cockpit conditions, speed and weight of the aircraft, Capt Hardie demonstrated exceptional knowledge, skill, and professionalism in the handling of this critical situation.

PTE J.M. LEBLANC

Pte Leblanc, an Engine Technician, was carrying out an AB inspection on a CH-136 Kiowa helicopter being prepared to continue on a lengthy cross-country flight with landing away from bases providing normal helicopter technical support. During his very meticulous examination of aircraft 136258, Pte Leblanc noticed that two hanger bearings appeared to have moved and the bearing housings had twisted through 90 degrees or more. The damage was not obvious to a cursory examination as the match marks had worn off. Additionally, there was no sign of over-heating of the hanger bearings and the Tempilaq condition and colour were quite normal. It is felt that the damage would have gone unrecognized during aircraft crew preflight inspections unless the aircrew involved knew exactly what to look for.

Further checks confirmed the damage to the tail rotor drive shaft and hanger bearings. Such damage could have led to catastrophic in-flight failure. Pte Leblanc is to be commended for the professionalism of his inspection and his insistance that the aircraft should not fly until a further check was made by a more experienced technician. His vigilance and meticulous attention during this inspection prevented a possible in-flight accident and, perhaps, loss of life.

Capt M.M. Hardie



WO F.E. Brothers

MCpl R.T. Chater

Pte J.M. Leblanc

Maj K.D. Munro
Maj L.G. Lott

MCPL R.T. CHATER

MCpl Chater is the log control clerk at 403 Helicopter OTS. During a routine acceptance check on an aircraft log set returned to this unit after the aircraft had completed a periodic inspection at 2 AFMS, he discovered an error in the computation of operating life of the tension torsion straps. This was not critical as there was still time remaining before the component became time expired and the error was corrected at the unit.

However, MCpl Chater decided to thoroughly check all Aircraft Equipment Component History Cards for all unit aircraft. He found a serious error in the calculation of operating time of the fuel control unit installed in aircraft CH136 136222. The time expiry of the FCU was calculated on the basis of an incorrect entry of engine hours at the time of installation of the FCU. The engine time recorded was in hours since new rather than in hours since overhaul. As a result the FCU, which is a 750 hour component, and which should have expired at 1201.4 engine hours, was shown only to expire at 1662.8 hours. When this error was detected the FCU had been time expired for some 338 hours. MCpl Chater immediately brought this error to the attention of his supervisor who in turn notified 2 AFMS and requested that the FCU be changed. The component was removed and 2 AFMS reported that on inspection the FCU was in a hazardous condition with a very stiff input shaft that could have seized later.

It was only through MCpl Chater's meticulous scrutinizing of the component history cards and his cross referral to engine records that this error came to light. His determined, methodical approach to his job turned up a potentially hazardous situation which, had it not been discovered and rectified at that time, could have resulted in a serious in-flight failure of the FCU.

MAJ K.D. MUNRO MAJ L.G. LOTT

While on an Air Defence Exercise in a CF101, Maj Lott and Maj Munro heard a Tutor pilot calling Bagotville terminal several times with no reply. They told the Tutor pilot that they could hear him loud and clear and asked if they could relay a message.

The Tutor pilot stated that he was running low on fuel. When asked where he thought he was, he stated that he had undercast conditions below him but he estimated his position to be approximately 60 - 80 nautical miles west of Bagotville.

The CF101 crew advised the Tutor pilot to squawk emergency. As he did this the CF101 crew switched to GCI control and asked if they were receiving an emergency squawk. GCI indicated that they were receiving a squawk close to Val D'Or (some 250 nautical miles west of Bagotville).

The CF101 crew returned to the frequency of the Tutor aircraft and advised the pilot. They then asked him to dial in the Val D'Or tacan and Chibougamau tacan independently to confirm his position. This was done and confirmed.

The CF101 crew advised the Tutor pilot to divert to Val D'Or and that the aerodrome had the ground facilities to accommodate a Tutor. They gave the pilot the Val D'Or frequency and told him that they would advise Montreal centre of his emergency diversion.

The quick professional approach taken by Maj Lott and Maj Munro probably saved the Tutor pilot from ejecting from his aircraft.

CPL K.A. WENGEL

Cpl Wengel is an Aero Engine Technician cross-trained airframe employed in 450 (T) Helicopter Squadron working on the CH147 Chinook helicopter.

While preparing an aircraft for deployment to Baffin Island, Cpl Wengel discovered a loose bolt lying in an obscure corner of the driveshaft tunnel structure. Had this bolt moved in flight so as to come in contact with the driveshaft, the most probable effect would have been failure of the shaft. On this aircraft, failure of the shaft allows the rotors to contact each other with invariably catastrophic results. Cpl Wengel's conscientious attention to detail in the hectic period preceding a major deployment quite possibly averted the loss of this aircraft.

During a subsequent unit deployment to Camp Borden, Cpl Wengel, while conducting an AB check outdoors in below-freezing conditions, discovered a flight control bolt in a remote corner of the flight control "closet" which could be moved axially. Further inspection revealed the nut was partially backed off and the split pin was sheared. Failure of this bolt in flight would certainly have caused the loss of all yaw control and could have led to a fatal accident. A potentially catastrophic failure was avoided by Cpl Wengel's thorough and professional conduct under adverse conditions.

CAPT S.J. KUPECZ

While on a chase mission in a CF5 aircraft, Capt Kupecz encountered symptoms of a compressor stall. After retarding both throttles immediately to idle, he noticed that the left engine had flamed out. Capt Kupecz advanced the right throttle to maintain air-speed in a gentle climb and called the lead aircraft to rejoin as he commenced a relight attempt. When no Exhaust Gas Temperature indication was observed after 10 seconds, he placed the left throttle back to cut-off. Approximately five seconds later the left engine fire light illuminated for about two seconds. At this point Capt Kupecz activated the left main fuel shut off switch.

The pilot in the other aircraft reported that the exterior left section showed signs of heat damage. Having no further fire indication Capt Kupecz declared an emergency and returned to Base without further incident.

Capt Kupecz proved, by his actions, that he was highly knowledgeable about the CF5 emergency procedures and the possible consequences of attempting an air-start for more than 10 seconds. All of the actions taken during this critical emergency prevented the loss of a valuable aircraft.

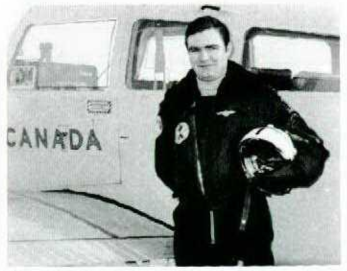
Because the aircraft was saved, the investigating team was able to arrive at valuable findings and recommendations which greatly affect the operation of the CF5 and Tutor aircraft engines.

1 LT A. VAN DER POEST CLEMENT

1/Lt Van Der Poest Clement, along with student pilot, Captain Kenty, was performing the downwind check for the CT-134 in accordance with the approved checklist when the engine failed. Several attempts were made to restart the engine, however, they were unsuccessful. At approximately 450 feet above ground, when it appeared that the engine would not restart, he continued to his preselected forced landing area (snow-covered ploughed field) and completed a successful forced landing with absolutely no damage to the aircraft or its occupants.

LT R.K. AGAR SGT R.H. DOBBIN

Lieutenant Agar was on duty as the terminal controller working in the tower on 19 Aug 75. At 1730 hours a Grumman American Tiger (C-GHEC) on a VFR flight plan from Swift Current to Brandon encountered weather below VFR limits and the pilot asked to divert to Moose Jaw but was unsure of how to get there. The weather at base was seven hundred overcast with ten miles visibility in light rain. The pilot advised that he was not qualified to fly IFR but the weather was deteriorating and some form of action was necessary. Lieutenant Agar through his experience was aware of the poor VFR radios in the temporary radar unit and this coupled with a probable inexperienced pilot led Lieutenant Agar to wisely have the aircraft remain on tower frequency.



1Lt A Van Der Poest Clement

Pte P.A. MacDonald

Capt S.J. Kupecz

Sergeant Dobbin, who was the radar controller on duty was immediately made aware of the problem and was able to quickly identify the aircraft and passed headings through Lieutenant Agar to the pilot. By this time the pilot was becoming disorientated and concerned for his safety but through a calm professional approach to the immediate task, Lieutenant Agar and Sergeant Dobbin vectored the aircraft to final. The pilot finally advised he had the runway in sight about two miles ahead. The weather had deteriorated to a point when the aircraft landed that the visibility from the tower was about one mile in rain. Lieutenant Agar and Sergeant Dobbin are commended for the efficient and professional manner in which they conducted this weather emergency.

PTE P.A. MACDONALD

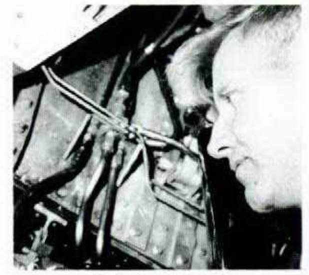
While carrying out AB checks on transient T-33 aircraft Pte MacDonald found two separate unserviceabilities, that could have led to serious consequences if they had not been detected in advance. Both of the items were not on the check list for AB checks.

In the first instance Pte MacDonald found the ballistic line in the rear seat position badly crimped. This flexible ballistic line is from the right arm rest M32 initiator to the seat quick disconnect. The crimped line could have caused a possible malfunction of the rear seat ejection system, as it could have possibly restricted the flow through it, which is the start of the ejection sequence.

During a following AB check on another transient T-33 aircraft Pte MacDonald discovered another dangerous situation. The canopy quick disconnect was completely disconnected. This would have prevented the jettison of the canopy prior to seat ejection because the quick disconnect is part of the main ballistic line going to the M5A2 thruster which jettisons the canopy. This failure would have meant that the front and rear seats would have had to eject

Cpl J.H. Knockwood

Cpl H.P. MacDonald



Cpl D.F. Fell

Mr. M. Hoffman Mr. D. Peterson

through the canopy if time did not permit the crew to unlock the canopy and open it manually or electrically.

Pte MacDonald is to be commended for her professional approach to both of these problems.

MR. M. HOFFMAN MR. D. PETERSEN

Following landing gear retraction on take off, the T-33 settled back onto the runway and in sliding to a stop off the far end of the runway, ruptured the starboard tip tank allowing fuel to escape and ignite spontaneously. Mr. Hoffman and Mr. Petersen witnessed the accident and immediately proceeded on an aircraft towing vehicle to render assistance, arriving at the burning aircraft virtually as soon as it came to rest. In spite of the fact that the tip tank was burning fiercely with an attendant risk of explosion, Mr. Hoffman and Mr. Petersen, without regard for their personal safety, contained and extinguished the fire with a hand held extinguisher from the towing vehicle. As the airport crash crew did not arrive at the scene for approximately five minutes their action undoubtedly prevented the total destruction of T-33 133604 by post-accident fire.

MCPL H.M. BEADLE

While performing ramp and hatch functional checks on a Chinook helicopter on periodic inspection, MCpl Beadle and MCpl Gillies found that the sequence rod assembly was bent, therefore not striking the striker pad. This, in turn, did not give the proper sequence for the hatch operation.

Through their trade and aircraft systems knowledge, they deduced that the striker pad was installed 180 degrees out of position. When it was repositioned and tests carried out their theory was confirmed.

If this situation had been allowed to continue it is possible that damage to the aft end of the aircraft would occur through out of sequence operation of the ramp and door.

Subsequent investigation revealed that the problem was present on all CH147 aircraft, and the manufacturer has acknowledged that the striker pad had indeed been installed backwards.

Master Corporal Beadle is to be commended for his professionalism in discovering this hazardous situation and preventing damage to a valuable aircraft.

CPL H.P. MACDONALD

While performing a monthly inspection on a jet aircrew oxygen mask assembly, Cpl MacDonald discovered a check valve installed in reverse in the bail-out bottle attachment point. Had this gone unnoticed and the bail-out bottle been required, the user would have received a minimal portion of oxygen with the remainder vented at the faulty connection. As this oxygen supply would only be activated in time of emergency, the resulting insufficient oxygen volume and pressure could have created a most hazardous situation.

It is due to the superior sense of responsibility displayed by Cpl MacDonald that this defect was discovered. The attachment point was not a checklist item for inspection and to see the check valve itself, required close examination. Further investigation revealed two other aircrew oxygen mask assemblies with the same defect. There is no doubt that through Cpl MacDonald's alertness and thoroughness, a serious in-flight incident may very well have been prevented.

CPL D.F. FELL

While carrying out an "A" check on an Argus aircraft, Cpl Fell noticed cracks on the main undercarriage hydraulic lines support brackets. These brackets are located in a tight and congested area that is very difficult to view. Cpl Fell inspected another aircraft and found more cracked brackets. He then passed this information on to his supervisor. The remaining unit aircraft were inspected and more cracked brackets were found. Cpl Fell's thoroughness and dedication prevented a possible Flight Hazard and lead to a vital special inspection.

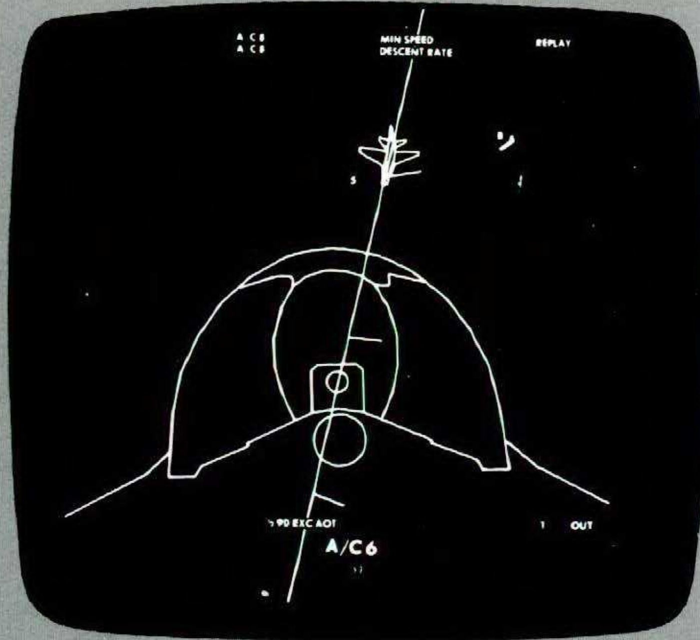
CPL J.H. KNOCKWOOD

While carrying out a routine "A" check on a CF101 aircraft, Cpl Knockwood noticed an apparently nicked compressor blade in the starboard engine. He investigated further by crawling into the intake and determined that the blade had been recently repaired.

Rather than terminate his investigation at this point, Cpl Knockwood persevered in his inspection of the engine and consequently discovered a bent blade in the third stage rotor. Subsequent stripping of the engine after removal confirmed his diagnosis.

Cpl Knockwood's keen observation and his diligence in going beyond the requirements of the check prevented a possible airborne emergency and saved costly repairs of the engine.

ACMR



an efficient training system

by R.K. Ferguson Capt, 433 ETAC

The Ground Instructor Pilots (GIPs) calm voice crackles in leads earphones, snapping him from his reveries.

"Papa formation, starboard turn heading 320 degrees. On roll out, bogies will bear 12 o'clock for 25 miles closing."

Papa lead acknowledges, automatically hunching forward in his seat. Ensuring Papa two's position with a sideways glance, he rolls into a starboard turn and verifies armament switches are set properly. The excitement mounts as he rolls out on heading. In pre-briefed arrangement with his wingman, his left hand advances the throttles to enable speed to increase to M.95. Tersely, he keys the mike. "Bogey dope."

"Roger, M.95 Papas." The Gips voice replies instantly. Two bogies bearing one o'clock for 25 miles, closing. Altitude about 15,000 feet, speed M.85. Turn starboard ten degrees."

"Papas." Eyes squint and probe ahead. The two CF5's, in defensive battle formation, roll out on the new heading.

"Papas, bogies now 15 miles your twelve o'clock. Appear slightly high reference your altitude."

Papa lead acknowledges, and checks a few more degrees to the right.

"Papa formation, Bogies bearing 12 o'clock, nine miles".

Papa two's voice cuts in excitedly, high and derse. "Papa's, bogies 11:30, two aircraft slightly high and closing. The left owe is going low!"

"Papa lead, talley, talley. I'm engaging the low man. Stay free and cover."

"Papa two."

Lead selects afterburner, breaking left. Two does likewise going high to cover lead, and relaying position of the other aircraft as necessary. Lead sees his bogie breaking left into him, and goes up into a high yo-yo conversion. Good judgement in completing this manoeuvre allows him to track the aircraft ahead. Immediately he fires an AIM9D, calling "Fox 2".

The Gips voice, after a slight pause "Roger, Papa lead. Good shot. Confirmed kill. Knock it off. Papas turn port heading 130 degrees for next engagement."

Lead acknowledges, and the two CF-5's roll out on heading. Two drops into position, flashing a thumbs up. Lead grins, resets armament switches, and thinks ahead to the next engagement, moments away.

Fantasy? Definitely not. Fascinating? Exquisitely so for the fighter pilot, utilizing the latest invention ever to bless the American Armed Forces. Its official designation? ACMR – Air Combat Manoeuvring Range, engineered and producted by Cubic Corporation of San Diego California. Its function to provide a realistic training medium for similar or dissimilar air-to-air combat including a debriefing capability second to nothing ever before invented.

433 Tactical Fighter Squadron based in Bagotville, Quebec, recently had an opportunity to travel to Yuma, Arizona, with five CF-5 aircraft, to accompany VFMA 321 Marine Reserve Squadron (flying F4B's). The intent was to utilize the ACMR facilities near Yuma, and to hone skills in air combat versus F4B's and A-4's. The ACMR complex was impressive to say the least!

Background

Jerry Ringer, of Cubic Corporation writes "Todays pilots are the best in history, better trained and manning the finest equipment technology can produce." The development of air-to-air, air-to-ground, and ground-to-air weapons systems has advanced rapidly in the past few years. Unfortunately, the cost of training pilots to effectively use this equipment kept pace with the advancements! Consequently, after results tabulated from Viet Nam experience indicated that about 50% of the air-to-air missiles fired by naval aircraft were launched from outside the missile envelope (and subsequently missed!), it became painfully evident that some kind of a training device had to be developed and implemented which would enable a pilot to utilize his armament capability more effectively. In March, 1971, the United States Naval Air Systems Command awarded Cubic Corporation a contract totalling $8.5 million for development of an ACMR. Development and installation followed, with terminals at U.S. Marine Corps Air Station, Yuma, Arizona, and the Naval Air Station (NAS) Miramar, California.

The concept of ACMR was inspired – simple in theory, complex in reality. A simplified description is given to assist the reader in understanding the overall system, followed by a more detailed discussion.

Aircraft are fitted with an airborne instrumentation pod system designed to adapt to regular missile rails. This pod is run by electrical current from the aircraft, and transmits flight data to ground receiver stations. These remote antennaes pick up these transmissions and relay them to a central computer complex (normally housed in trailers at the airdrome.) The computer analyses the data (as well as recording it on video tapes) and reproduces it simultaneously on two video (TV) screens. The Ground Instructor Pilot (GIP) has at his fingertips, dials which permit him to view the manoeuvring from a variety of angles and attitudes. He also receives instant and easy to interpret flight data from each participating aircraft. (The old model will handle four aircraft on printout data – the newer model eight). With this information at his disposal, the GIP can effect an intercept, and monitor the hassle once the aircraft are engaged. The GIP, in direct radio contact with the aircraft, can vector them as required, and call the disengage or "Knock it off" at any time.

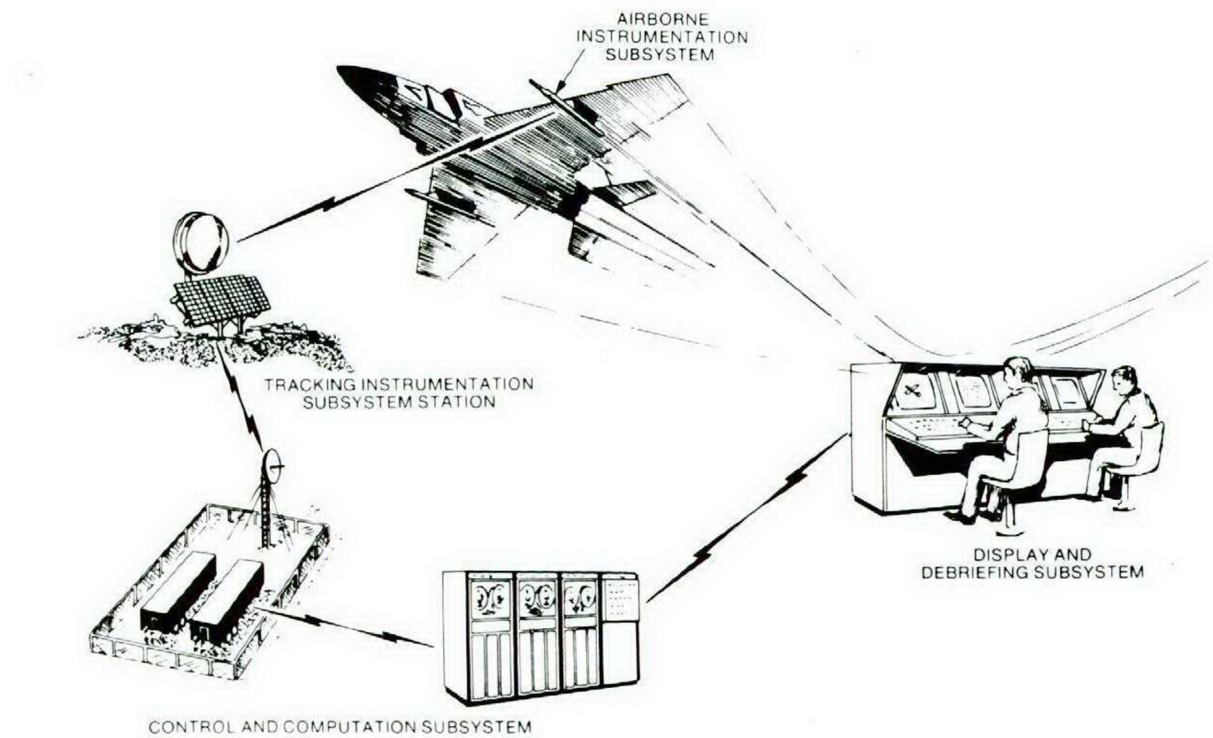
Prior to going airborne, the type of missile to be used in the flight is entered in the computer, in our case, Aim 9 Delta's. Once airborne, when a pilot arrives in a tracking situation, the pod will send a "pulse" to the computer when the pilot "fires", simulating missile launch. The computer takes over, using input flight data from each aircraft and known missile parameters, it predicts missile track and impact, displaying it on the GIP's screen. It will then indicate a "KILL", "CONDITIONAL KILL" (50-5- CHANCE – EDGE OF ENVELOPE) or "MISS". All this information is stored on magnetic video tape and can be replayed at will for debriefing purposes.

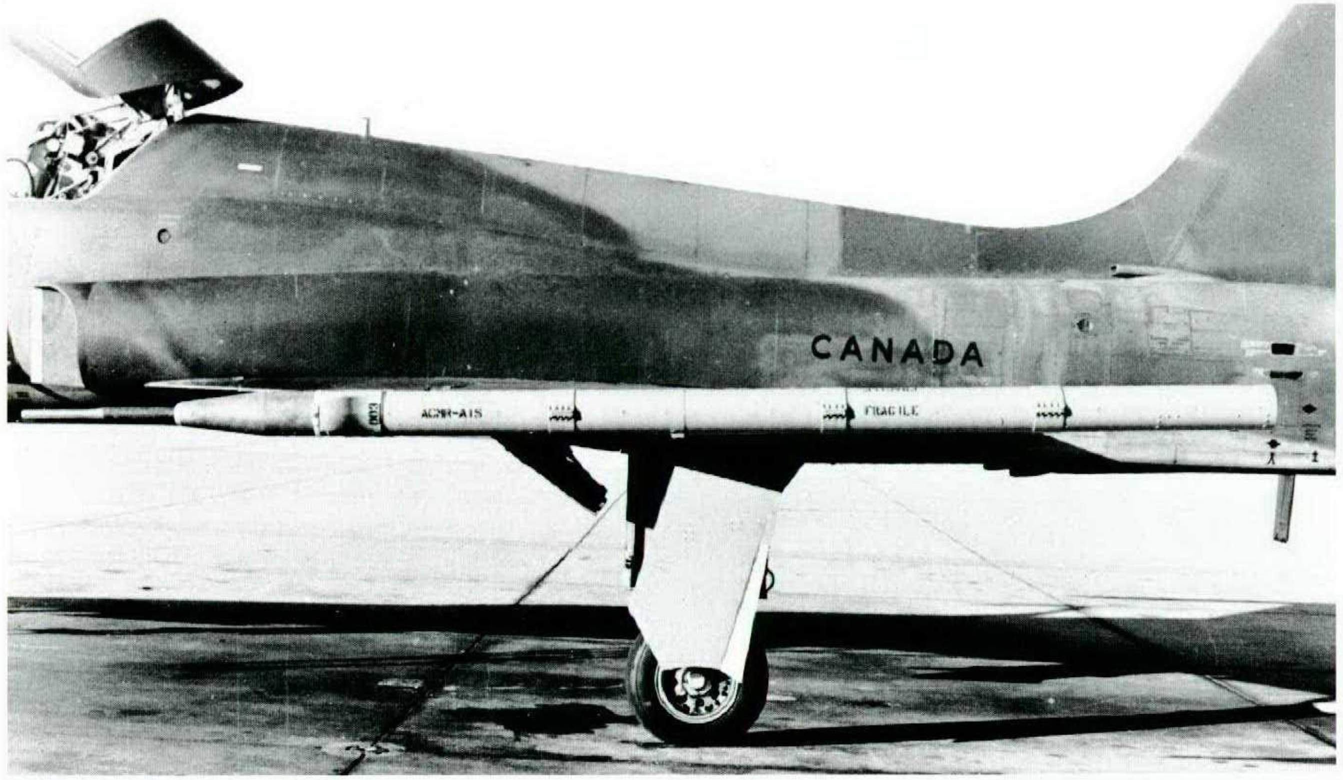
Analysis

A complete ACMR system is comprised of four major subsystems:

1) the Aircraft Instrumentation Subsystem (AIS pod);
2) Tracking Instrumentation;
3) Control and computation; and
4) Display and Debriefing consoles.

The AIS pod is a highly efficient and compact missile shaped cylinder, five inches in diameter and approximately 11 feet 7 in. length from tip to tail. It fits on a normal missile launcher rail and connects into the aircraft electrical system via an umbilical cord connected to the missile circuits already in the aircraft. (Uploading an AIS pod takes approximately five minutes!)





AIS pod on left wing tip of CF5

On the nose of the AIS pod is a standard pitot-static sensor probe which allows continuous measurement of inflight pressures that are subsequently converted into angles of attack, angle of sideslip, airspeed (IAS, TAS and indicated mach number). A compact strap-down inertial reference unit provides pitch, roll, heading, acceleration (including "G" forces), and velocity values. The balance of the pod is devoted to a transponder type signal relay system for continuous data transmission to ground receiving stations and tracking information. It also senses (and transmits) weapon firing functions!

The second subsystem — Tracking Instrumentation is comprised of small, unmanned, solar powered remote units controlled by a master station. Each unit consists of receiver transmitter equipment, ground-to-air omni antennea, ground-to-ground parabolic antennea, battery, and solar cell array for battery charging. Of these units, Cubic Corporation states in a pamphlet, "Because of their low power consumption and small physical size, these units can be mobile, man packed, or placed on small fixed towers. If the environment does not permit solar cell use, the battery can be recharged by a propane fired thermoelectric generator."

Units are located in line of sight to the master station. This network can simultaneously compute accurate multiple ranges of up to 20 aircraft (24 on the new model), although only eight of these (new model) can be paired for inter aircraft references at all times. As an aside, the ground tracking units in Yuma were roughly in a circle of 35 nautical mile diameter. Even then, accurate ranging information was portrayed by aircraft transmitting well outside that range area!

The master station includes: a controller and processor; distance measuring equipment, data link equipment, (ground-to-air, air-to-ground, and ground-to-ground to and from the control and computation subsystem); time of day clock; a calibration transponder; an atmospheric sensor; and the all important voice communication equipment. It automatically selects the optimum communication path between aircraft and ground receiver units, and feeds all the data back to the central computers in the Control and Computation subsystem.

The third subsystem houses the brain of the ACMR three Sigma 9 computers. This data processing system provides real-time outputs pertaining to aircraft state vector, interaircraft parameters, missile simulations, and reasons for miss. It interprets all this information and instantly converts it into symbols for video presentation at the last subsystem site.

The fourth subsystem — Display and Debriefing (DDS) — is where the value of the ACMR complex becomes apparent. It is housed in a large van (adjacent to the Control and computation computers), each end of which contains display consoles for real-time mission control or debriefing. The middle portion of the van contains the tape-drive systems which record the data as it arrives from the Sigma 9 computers.

The DDS incorporates two basic types of displays: a graphics display on one screen and an alphanumeric status display on a second screen.

The graphics display monitoring tube portrays a 3-dimensional view of the air combat as it takes place. As the aircraft approach one another, the GIP (Ground Instructor Pilot), at the touch of a button, can halve the range (i.e. 40NM - 20NM-10NM-5NM-2.5NM) diameters, in order to keep the aircraft "separated" enough on his screen to identify individual aircraft. To assist him in this task, is another button which, when depressed, instantly centers the "flight" on the screen. The GIP can also twist two knobs on the console, allowing him to rotate the display in any axis he desires. He is now able to view activities from a plan view, top view, head-on or stern view, or any combination thereof! Touching another switch permits him to have a simulated pilots view from any aircraft involved in the hassle — he literally sees through the windscreen what the pilot in the selected aircraft is seeing! Its like watching a 3-D computer drawn motion picture!

Critical flight parameters such as airspeed, altitude angle of attack, "G" forces, range between aircraft, relative velocity between aircraft and missile firings are amongst the information capable of being displayed on the alphanumeric status monitoring tube.

Since each aircraft is represented by an aircraft symbol and number on the GIP's screen, he can monitor flight parameters of individual aircraft as the air combat progresses the GIP can provide a variety of services to the pilots, warning them of overspeeds, overstress, altitude violations or potential collision courses. He can assist with rendezvous information of an aircraft which has become separated from the fight, or with aircraft desiring to return to base together. He is able to tell pilots if they are leaving the range area (important, if for example, an airway runs along one edge as it does at Yuma), and if another aircraft (who has his pod turned on) is entering the area as such, the ACMR assumes a high potential for flight safety, augmenting its value a hundred fold.

Anyone who has flown an aircraft in ACM knows the difficulty in conducting effective debriefings, due to the number and complexity of manoeuvres which takes place during each engagement. Not so with the ACMR! During post exercise replay of the video tapes, various views of the 3-D display can be selected and changed without regard as to what views were previously selected by the GIP during real-time monitoring. The tape can be halted and the information "frozen" at any time (or replayed) until debriefing items have been discussed to everyones satisfaction. Missile firings are indicated by the word "FIRE" appearing on the tube, and a line of flight predicted and simulated by the computer as it races towards its target. At "impact", the information is automatically frozen, and readouts on range, relative velocity, "G" load, and angles-off-the-tail indications.

That the console is not too complicated even for a novice, was attested by the fact that the author was personally checked out on its operation over a noon hour, and subsequently successfully acted as GIP for several engagements involving two to four aircraft.

433 ETAC pilots who flew on the ACMR at Yuma were all highly enthusiastic. Each felt his ACM level of experience doubled or tripled in the two short weeks we were there. Immeasurable value was derived from debriefings, as pilots witnessed their own performance in relation to the others. Experience quickly grew as pilots became increasingly aware of tactics, missile envelope parameters, personal and aircraft limitations. It was a unanimous consensus that experience gained from the ACMR would undoubtedly lower losses to the enemy in air-to-air combat by a significant factor, should we be called upon to go to war.

Adaptability and Development

The beauty of the ACMR lies in its inherent ability to be adapted to other situations. For example:

a. *Air-to-ground* An Airborne Range Instrumentation System (ARIS) can be utilized (*without* modification to most aircraft). It is an operational, high precision, no-bomb drop scoring system which predicts weapon impact points to an accuracy of less than 20 feet (and is not limited by aircraft attitude or manoeuvre). The ARIS is presently qualified on A-6 and F-111 aircraft.

b. *Ground-to-air* Simulations for example, of blowpipe missiles could be incorporated into the ACMR, there by assisting land forces in use of this weapon.

c. *Search and Rescue*. The Electronic Location Finder (ELF) operational in US Army and Marine Corps (and successfully used in Southeast Asia), allows a pilot to acquire a ground beacon signal, steer to it, and hover blind overhead with a position accuracy of 4-8 feet. ELF is also used for resupplying, precise air-dropping, and foul weather homing, and as such could be readily adapted for use by ground forces.

d. *Weapon Tracking* By adding the weapon tracking device to the ACMR system, it will track live firing of ordinance in the air-to-air, air-to-ground, and surface-to-air modes. This could assist any agency wishing to test a particular ordinance.

Cost Effectiveness

Roy S. Johnston, Program Manager for Cubic Corporation writes: "According to U.S. Navy analysis, the ACMR 1 system saved approximately $100-million by reducing missile expenditures and lowering aircraft accident rates during the first 18 months of operation. Even though the Canadian Air Force training program may involve more limited expenditure of missiles and flight time, the ACMR/1 system offers the most cost effective approach to air combat readiness in existence today. In most cases, the cost of an ACMR/1 system will be equaled in savings within one years operation or less."

Jerry Ringer of Cubic adds: "A factor that cannot be estimated in figuring costs is the number of pilots who will not crash because of the superior monitoring devices."

It is also the authors humble opinion that experience gained by peace time use of the ACMR will pay dividends many times the cost of the system in aircraft (and pilots) saved in a war time situation.

Advantages to Canada

An ACMR system, designed for Canadian climatic conditions (and installed for example at CFB Cold Lake) would present many advantages to the Canadian Armed Forces. Assuming the NFA (New Fighter Aircraft) is on its way, training value could be maximized while minimizing risk to new and expensive aircraft by virtue of its unique monitoring capability. Air-to-air Combat and Air-to-ground deliveries could be accurately simulated for use by aircraft now employed in Air Defence, Tactical Strike and close air support roles without the inherent risks and costs of actual weapons. Land Forces could utilize its capabilities. AETE would have an improved monitoring and recording capability for test flights and weapons trials. Invaluable dissimilar ACM experience could be obtained by inviting USAF and US Marine aircraft to visit out range (bringing their own AIS pods). Because of a competent GIP's ability to monitor flight parameters and assist/warn pilots of several situations, the Flight Safety potential increases the viability of the ACMR a hundred fold. "Classic" attacks or special occurrences could be placed in a library and rerun for the benefit of student or new squadron pilots, assisting them to increase their levels of experience quickly and efficiently.

The ACMR is an innovative and intriguing system employing the latest in technology. It is cost effective and adaptable to several varied functions. Its numerous advantages permit or degree of training hither to unattainable. International interest is such that over twenty sales are anticipated by Cubic — should we not also be seriously considering the advantages it could bring to us? In a time of diminishing resources and manpower, the ACMR would assist the Canadian Armed Forces in maintaining peak combat readiness through maximum and safe utilization of available training time. Is this not what its all about?

STORM WARNING

Tracking a thunderstorm from birth to maturity might make you afraid of one. Let's hope so.

A small updraft lifted a spiral of dust high into the heavy afternoon sky. As the updraft strengthened, it uplifted a hawk which had been seeking prey in the grass below. The hawk spiraled with the rising air for awhile, then banked away. Far above the circling hawk, a small cumulus cloud formed.

Fueled by the heat of the afternoon, the humid air rose quickly, its moisture adding to the now rapidly building cloud. Updrafts and downdrafts began to clash, creating waves of turbulence. More small clouds formed and merged with the first. Within the darkening mass, lightning flickered.

Miles away, a weather observer carefully noted the distinctive configuration of the cloud mass. Unable to hear the distant rumble of thunder, he reported his observation as a cumulonimbus (CB).

A second, closer observer, his view of the sky blocked by low clouds, listened carefully. His observation of the same phenomenon would bear its more frightening name: Thunderstorm.

The pilot of Conch 41 noticed the storm as he steadied his fighter onto its assigned heading and leveled at 8,000 feet.

"How's it look to you, 42?" he asked his wingman, now some three miles in trail and 2,000 feet higher.

"Don't think we're anywhere near the base, but we might clip the edge of it on this heading."

"Yeah, looks like it. I doubt if there's anything in it, though. Top can't be much above 20,000. Should miss the bad stuff at this altitude."

At their previous base hundreds of miles south, both pilots had seen and avoided many monstrous storms. And yet, neither seemed to realize that the smaller thunderstorms of northern latitudes can be just as violent as their gagantic relatives in the south.

The fact that the worst turbulence is created, during a storm's building stage did not seem relevant to their present situation, although both knew that it was unwise to attempt a penetration of any thunderstorm at any altitude. Somehow, this one didn't gain their respect as had the larger ones they had seen down south.

"Approach, Conch 41. We've got a buildup ahead; looks like we might skim the edge of it. How about 15 degrees right?"

"Sorry, 41, I've got opposite direction traffic. How about a left three-sixty?"

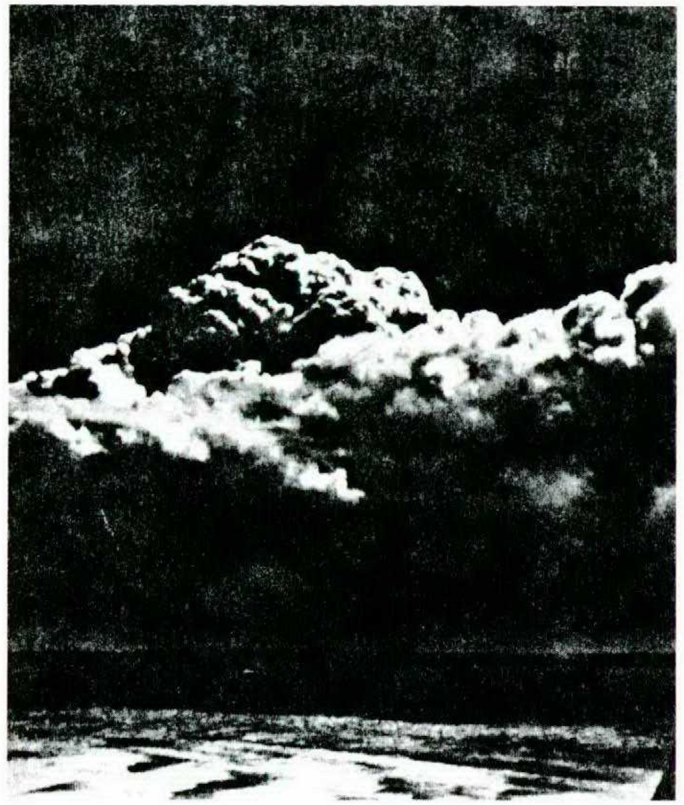
Lead glanced at his instrument panel. "Uh, don't think so. We're a little tight on fuel." He looked ahead at the storm and reluctantly made his decision.

The left horizontal stabilizer failed first, then the right wing.

"Guess we'll just keep on; doesn't look too bad, anyway. Let me know when we can turn."

"Roger, 41."

The updraft hit his aircraft just as it entered the storm. The pilot grunted as the G forces shoved him lower into the seat. Still, it wasn't too bad; he'd flown through thunderstorms before, and his airplane was built to take it. He eased



forward on the stick, trying to maintain a level attitude, and saw that even at zero G the aircraft was climbing at 6,000 feet per minute. He added a little more forward pressure and waited for the updraft to abate.

It did-suddenly and violently-and a 100-knot downdraft slammed the fighter toward the ground. The pilot's vision went red as negative G's tore at his body. The left horizontal stabilizer failed first, then the outboard section of the right wing. There was just time for a single desperate "Maday" before the ejection seat blased him clear of the tumbling aircraft and into the violence of the storm.

Conch 42 heard the call and guessed what had happened. As he anxiously circled near the edge of the storm, hoping for the sight of a parachute, he was too concerned to notice the near-freezing temperature of the outside air-well within the temperature range most conducive to lightning. He had no way of knowing that the mixture of vapor and air in his fuel tanks was also near 0°C, or that this mixture was most highly explosive at this temperature.

His eyes were blinking from the lightning as the exploding tank ripped the aircraft apart.

The storm gathered speed in its eastward movement and a student pilot watched it warily from the cockpit of his light plane. About ten miles away – time for maybe one or two more landings. He had no intention of being in the air when the storm arrived. He knew that even if the storm should miss the small airport, the clear space to the southwest could be a spawning ground for a tornado.

As he turned final for one last approach, the advancing wall of cloud approached him from behind. He did not see the line of dust spewing into the air as the storm rapidly neared

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SURVIVAL PHILOSOPHY

by Capt J.D. Williams

If we're going to talk about – or in grandiose terms "philosophize" about survival I suppose it would be appropriate to define the term. For the purposes of this discussion we will define survival as those efforts required to exist successfully in *isolation* using minimum *basic tools* and *knowledge* of living with natural elements and resources.

Now there are various ways of arriving in a survival situation – some of them being ejection, ditching, forced landing and crashing – and naturally dependent upon the "means of arrival" will be the degree of isolation, the availability of tools and equipment – and even the quantity and quality of knowledge – in the sense that two people may know more than one – or that one person may be trained and another untrained.

Also it is important to remember that the locality in which our survivor finds himself can have a crucial input – we could generalize and state that the possibilities include the sea, the arctic, the desert, the tropics, or temperate zones – with the complicating factor of season and weather. Each of the possibilities may require specialized equipment and knowledge – although we can probably assume some degree of commonality – since we're talking about the survival of a common organism wherever it may be.

So far this may sound a little fuzzy – for a very simple reason. The question is – or was fuzzy – and so a variety of agencies were tasked with formulating a survival philosophy for the Canadian Armed Forces. To remove the fuzziness as it were. Among the agencies involved were DCIEM, DAR, DAOT, DAES and DFS – and if I've left any initials out please accept my apologies. I got involved on the behalf of DFS – I suspect because I own a typewriter – and for that reason many of the views you are going to hear or see are going to be mine.

Essentially the idea was to take a three pronged approach. First, it seemed logical to examine all our prior survival experience, delving as far back into antiquity as possible.

Second, it seemed equally logical that having done so, we should eliminate that portion of the aforesaid survival experience not considered currently valid. Third, it seemed appropriate to postulate certain demands likely to arrive in the future in terms of roles and equipment. As an illustration – there is little value in providing the same equipment which would have been carried in a Harvard enroute from Penhold to Centralia to an Aurora working out of Frobisher. The demands are obviously different.

Furthermore, there is more to the question than simply what to put in a survival pack – the entire scenario must be studied – since as an example Search and Rescue facilities and requirements must be taken into consideration. It would be a pity to provide a downed airman with a UHF beacon and all the search vehicles with only VHF capability.

Anyway, the idea of the study which was set up was to develop a coordinated survival philosophy employing current state of the art technology in so far as this technology is available or likely to become available to the Canadian Armed Forces.

I don't think it is an unacceptable oversimplification of the matter to state that there are only two requirements for survival – anywhere – and those are

1. TRAINING and
2. EQUIPMENT

Naturally with the right training and equipment one could survive comfortably on the dark side of the moon.

– Of the two requirements it is probable that training is the more important – first of all because it is crucial in instilling the all important "will to live" without which all is lost – second because studies have shown that with todays city bred soldier the ability to survive in the wilds doesn't come at all naturally – and third because – unfortunately due to space limitations – the amount of equipment available has to be severely limited. I think you will agree that if you observe an infinite number of aircrew throughout all the seasons of the year, you will very soon come to the conclusion that they can be divided into two easily recognizeable groups which I have chosen to call "The Campers" and "The Signallers".

The campers concern themselves with such items as knives, hatchets, fishing line, sleeping bags, mosquito nets, chocolate bars etc whereas the emphasis among the signallers is upon radios, flares, mirrors, signal panels, whistles and so on.

Both groups tend to agree on the need for such items as parachutes, Mae Wests, dinghys etc – which indicates agreement with the basic needs principle. Simply put this is "If you're dead – you don't need anything. If you're alive on the other hand, there are a few things which are required." Both the signallers and campers have analyzed the problem and broken it down into its two component parts

1. Staying Alive and
2. Getting Rescued.

Aircrew Life Support Equipment Officers are tasked with providing survivors with both these capabilities – and additionally with ensuring that they take advantage of the capabilities we provide. To illustrate this last point I will simply say that a poopy suit hanging in the alert hangar in Chatham is of precious little value to a navigator floating in the Gulf Stream. We provide the suit but the man has to put it on himself.

We are currently involved in a continuous process of tradeoffs. We take out food and put in a better beacon – but we musn't neglect to provide the pickup capability to back up the beacon. We musn't forget that we have little or no fast offshore capability, few rescue resources deployed in the Arctic and some of the worlds most wretched weather conditions. Were we capable of providing four hour pickup for the survivor or survivors of the Kiowa crash in Newfoundland last winter? No. Weather prevented us from getting to the crash site – even prevented us from ascertaining if there had been a crash. For those men the choice between signalling and camping was not theirs to make. Did we provide the right equipment, the right training? Equipment of course becomes a critical matter – if you can't have much it is nice to at least have the right things. You've got to have the correct material – and it has to be reliable. Furthermore – it has to *be there* when you need it.

Think of this as a challenge

– you are given one adult male Canadian, suitably clothed for a flight in a CF100 out of North Bay in February. Employ-

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the field.

The gust front struck the aircraft from the rear with a velocity almost equal to the aircraft's final approach speed.

Panicked by the stall warning and the quickly increasing sink rate, the student's first reaction was to pull back hard on the yoke.

The stall warning was still blaring as the tiny aircraft struck the trees short of the approach end of the runway.

Far above, in the smooth, sunlit air at FL 240, the crew of a military transport listened to the wail of the light aircraft's emergency locator transmitter. They reported the signal to Center and then turned their attention to the spreading top of the storm.

"What do you think, Jim – have we got enough clearance?" The copilot wasn't really anxious, simply curious.

"I'm pretty sure we do," the AC replied. "We ought to pass about ten miles east of it, according to the radar. Besides, I think we're a little above it. No problem."

They were ten miles east of the main storm body when hail began to hammer at the aircraft. Spewed from the seething top of the storm and carried eastward on the strong westerly wind, it ripped into the plane like shrapnel. A large chunk of the radome was swallowed by the number two engine. The engine disintegrated. Pressurized air swooshed out of the aircraft through a cabin window which had been shattered by flying compressor blades.

Minutes later, the aircraft was level at 10,000 feet. The emergency was under control. But for one passenger, an elderly man whose heart had been unable to stand the stress of the decompression, it didn't really matter.

As the crippled transport made its approach to a large civil airport, Transamerican Flight 43, in a holding pattern, waited for approach clearance. Finally, the military aircraft was safely on the runway, its emergency terminated.

"Transamerican 43, turn left, heading 220. You're cleared ILS approach runway 26 left; be advised we have rain showers moving across the approach end."

"Transam 43, roger," the first officer acknowledged.

"Could be a little shear on final," the captain remarked to his first officer. "Let's carry about 15 knots extra, just in case." He watched the radar, which showed a small echo moving southward toward the approach end of the runway.

The pilots saw rain ahead as they broke out of the clouds at 600 feet. It wasn't heavy, considered a missed approach. Then he remembered his limited fuel reserve and the extensive delay involved in sequencing for another approach. Glancing at his airspeed indicator and reassured by the 15-knots pad, he continued.

The headwind came first, ballooning the aircraft above glide path. The captain reduced power and lowered the nose, then turned his attention to the runway lights, dimly visible through the rain. Neither he nor the first officer could feel the headwind suddenly die and the aircraft suddenly in a downdraft – sink at 1,500 feet per minute. Then, a strong tailwind. The airspeed dropped to 20 knots below approach speed; the first officer shouted a warning. The engines were firewalled, but the airliner slammed into the steel pillars of the approach lights.

The radio announcer's voice was somber as he told of the fiery crash at the city's major airport. Several miles east of the city, a man listened, his face grim. Then he walked to the front door, opened it, and shouted into the rising wind.

Trees bent in the wind, their leaves pale and strange in the eerie light.

"Tommy! Get in here – now!" There was anger – and a note of fear – in the father's voice.

"Aww, Dad . . . " Reluctantly, the ten-year-old began walking toward the house, turning now and then for another look at the advancing storm. Lightning forked down, followed almost immediately by a blasting concussion of thunder.

Safe inside, the boy pressed his nose to the window. Trees bent in the wind, their leaves pale and strange in the eerie light. He shivered.

"Scared, son?" His father smiled.

"Oh, no, Dad, not a bit. Well, maybe just a little." He looked up at his father. "That's okay, isn't it, Dad? To be a little bit scared of thunderstorms, I mean?"

"Nothing wrong with it at all, Tommy . . . " He ruffled the boy's hair reassuringly.

Lightning struck again with a deafening bang; rain pelted against the windows.

" . . . nothing at all."

courtesy of The Mac Flyer

SAFETY IN RETROSPECT

"Whoever considers the past and the present will readily observe that all cities and all peoples are and ever have been animated by the same desires and same passions; so that it is easy, by diligent study of the past, to foresee what is likely to happen in the future in any republic, and to apply those remedies that were used by the ancients, or, not finding any that were employed by them, to devise new ones from the similarity of events. But as such considerations are neglected, or not understood by most of those who govern, it follows that the same troubles generally recur in all republics."

Quote from Machiavelli's – The Prince

Within those words lies the ultimate reason for accident investigation and reporting, data collection and trend analysis, as well as the starting point for safety techniques. How well we do in preventing accidents depends largely on how diligently we evaluate past mishaps and retain lessons within our corporate memory. The Air Force has developed the tools to collect and apply painfully learned lessons. Time-proven methods of preventing and lessening the severity of accidental losses are abundantly available and must be used by managers in all functions.

We all have both a legal and moral responsibility for the prevention of accidents. Supervisors must provide leadership and guidance, while the worker is responsible for adhering to job safety procedures. All individuals working together to achieve an accident-free work environment is the only way any safety program, be it civilian or military, can be successful.

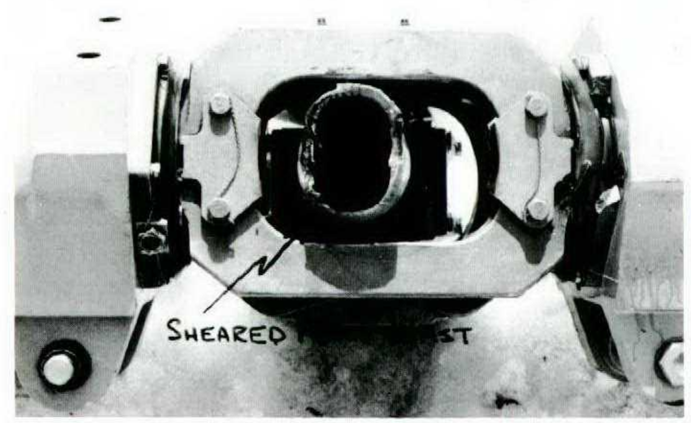
HAROLD E. CONFER
Brigadier General, USAF DCS/Logistics

accident— TWIN HUEY

The aircraft departed Cold Lake airfield with a crew of three on a project test flight with floats and loud hailer fitted. An hour later the burning wreckage was discovered on the frozen surface of Cold Lake by a T-33 aircraft in the airfield circuit. All crew members were fatally injured.

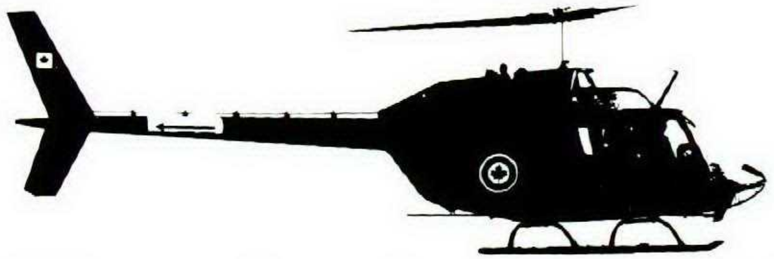
The cause of this accident is still undetermined and the investigation is being continued. Investigation to date has determined that for unknown reasons, the aircraft experienced mast bumping followed by main rotor separation and inflight break-up.

Masking Tape marks rotor cut points on tailboom.



Colonel John R. Chisholm
Director of Flight Safety
Canadian Armed Forces

Colonel Chisholm joined the Royal Canadian Air Force in 1956 after three years at the Collège Militaire Royal de St Jean, Quebec. Upon completion of pilot training he served six years at Bagotville, Quebec, flying CF100 all-weather fighters and serving as the Station Flight Safety Officer. A three year exchange tour with the Royal Air Force followed during which he flew the Lightning all-weather fighter. In 1966 he was promoted to Squadron Leader and appointed Senior Staff Officer Flight Safety in Air Defence Commander Headquarters. Following Staff College in 1970 he was posted to 427 Tactical Helicopter Squadron flying CF135 Twin Hueys in support of the Army. He was then posted to 403 Tactical Helicopter Operational Training Squadron as Chief Instructor. In 1973 he was promoted to Lieutenant Colonel and assumed command of the unit. He moved to the Directorate of Flight Safety in Ottawa in 1976 as Head of the Investigation and Prevention Section and was promoted to Colonel in 1977 to assume the position of Director upon the retirement of Colonel R.D. Schultz.



A Close Look at Mast Bumping

by Lieutenant Colonel James A. Burke, USAAAVS

LTC Burke, a senior Army aviator, is currently assigned to the Aviation System Division, Deputy Chief of Staff for Research, Development and Acquisition. He was assigned to the U.S. Army Mobility Research and Development Laboratory as R&D coordinator at the time this article was written. LTC Burke holds a graduate degree in Aeronautical Engineering from Texas A&M University.

A critical condition can exist on helicopters having a teetering rotor design when the rotor hub makes inadvertent dynamic contact with the rotor's mast. This applies to all UH-1, AH-1, and OH-58 helicopters. If contact is sufficient to cause an indentation of the mast, the driving torque of the engine can ultimately twist or sever the mast. So let's take a closer look at the mast bumping phenomenon so that, as aviators, we can understand the ways to avoid conditions which contribute to excessive hub flapping leading to mast separations.

Accident data shows that 50 mast separation inflight breakup accidents have resulted in 189 fatalities and a cost of more than $50 million. Although in most cases the accident investigation efforts were plagued by uncertainties, lack of eyewitnesses and postcrash fires, the one common trend of occurrence was severe mast bumping, followed by mast separation in the static stop area of the main rotor hub. Admittedly, materiel failure of critical components may have initiated the sequence, but the cause of each catastrophic mishap was truly separation of the main rotor mast due to severe mast bumping.

Realizing that mast separation can occur, the purpose of this article is to help operators understand the major contributing conditions which "set the scene" for mast bumping.

Figure 1 is a schematic version of a simple teetering rotor. The rotor's design allows the main rotor blades to flap about a common pivot point to compensate for dissymmetry of lift. Typically, the 12-degree flapping is quite adequate for normal operations and has been conclusively proven by instrumented test flights and many years of production flight operations to be quite reliable and relatively trouble-free. However, it is important to note that the rotor hub can contact the rotor mast if the main rotor hub flapping is of the order of 12 degrees. So our job as aviators is really quite simple, mainly to operate our helicopters in such a manner that the rotor hub's deflection is well behaved to flapping values considerably less than 12 degrees.

Without dwelling on the exact technical details of the analysis, certain conditions contribute to excessive flapping. We can expect flapping to increase by values shown in table 1.

For reference, typically, a fully loaded teetering rotor helicopter operating at maximum gross weight, full forward c.g. at 90 knots cruise on a standard day, 2,000 feet, is characterized by rotor flapping values of 2 degrees to 3 degrees. However, should other conditions like those listed in III and IV of table 1 be present, a rapid buildup in flapping can develop. For example, a simulation experiment of a UH-1H has verified that a simple engine failure followed by an abrupt autorotation entry with a c.g. offset of 6 inches forward of allowable limits caused flapping values in excess of 12 degrees. While this unlikely flight configuration is an extreme example, flights were made in Vietnam under these conditions. Had this experiment been an actual flight situation, severe mast bumping could have destroyed the aircraft.

It is not commonly known that sideward velocities of approximately 30 knots *to the right* cause much higher flapping angles than sideward flights to the left. Specifically, right sideslips can develop as much as 9 degrees flapping as opposed to 4 degrees to 4½ degrees of flapping under the same condition when hovering or sideslipping to the left.

Category IV operations with low g-loadings seem to impose the greatest operational restraint to teetering rotors from a mast bumping standpoint. By design, this rotor requires positive values of g-loadings for cyclic control. Flight tests have generally confirmed that anytime we operate at g-loads less than 0.5 g the aircraft will start to show adverse signs of control response, and as the g-loading is reduced to approximately 0.2 g's, functional loss of effective cyclic control is fully developed. Hence, we must refine our techniques to ensure that our flight regimes sustain a positive g-load of no lower than 0.2 g. (The OH-58 flight handbook carries a warning that prohibits flight below 0.2 g.) This may be somewhat challenging in view of integrating advanced helicopter tactics into operational use. In looking at the advanced concepts of employing aerial scout vehicles and armed helicopters, certain tactical maneuvers like the ones shown in figures 2 through 6 should be prudently conducted with the thought in mind of retaining positive rotor control by flying with a reasonable positive g-load.

One way aviators can help prevent mast bumping is to operate within the c.g. envelope of the aircraft. For example, every inch the c.g. is displaced forward, the flapping values are increased by approximately 0.5 degrees. So, logically, a teetering rotor helicopter whose loading is such that the c.g. is displaced forward by 6 inches can expect an increase in flapping of 3 degrees. Consider the case of the c.g. located at 6 inches forward of normal limits (perhaps a typical combat-loaded situation for a UH-1H). Should the aircraft be subjected to an abrupt trim change (like a tail rotor failure), the flapping values related to tail rotor failure combined with those of the c.g. offset may lead to mast bumping. Conclusion: Keep the c.g. within limits!

Mast bumping is real; it can occur if we operate teetering rotors incorrectly; and it must be prevented. The lesson to be learned from this discussion is this: Operate your aircraft within its design envelope.

Army Aviation Digest

GROUP	CONTRIBUTING CONDITIONS	TYPICAL FLAPPING VALUES
I	High forward airspeeds Low rotor rpm High density altitudes High gross weights	1°-2°
II	Turbulence	2°-3°
III	Sudden trim changes Center of gravity offsets High sideslip velocities–rightward direction	up to 9°-10°
IV	Low g loading	up to 12°-13° (or greater)

TABLE 1

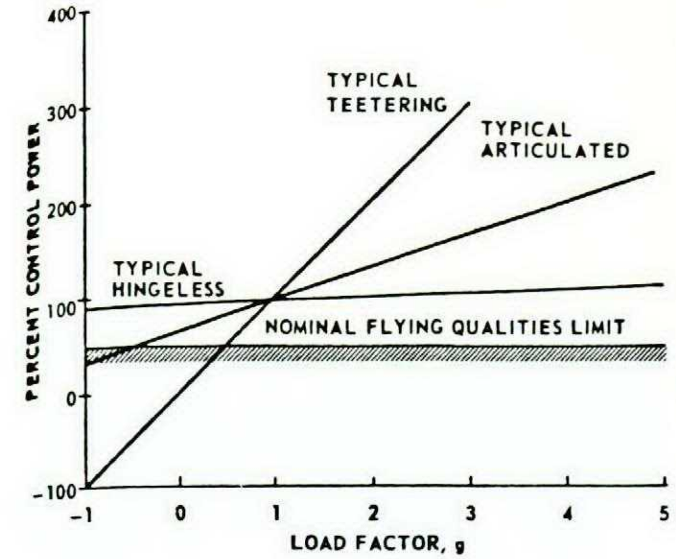
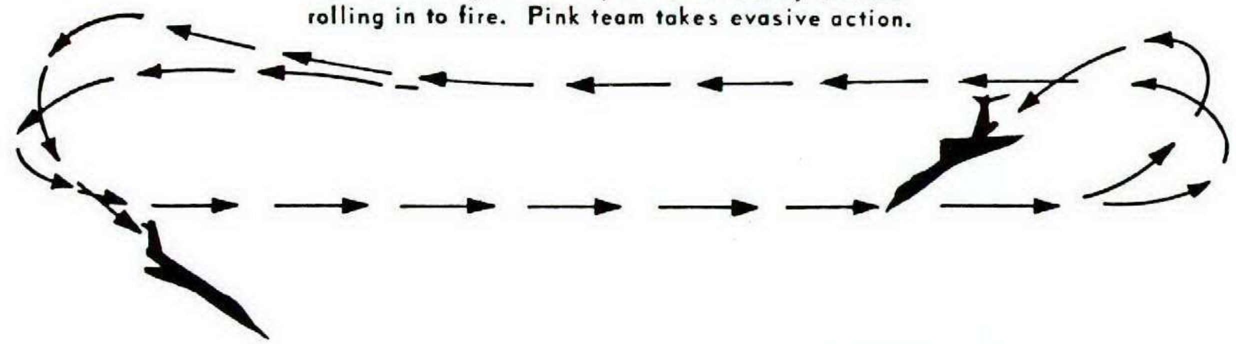
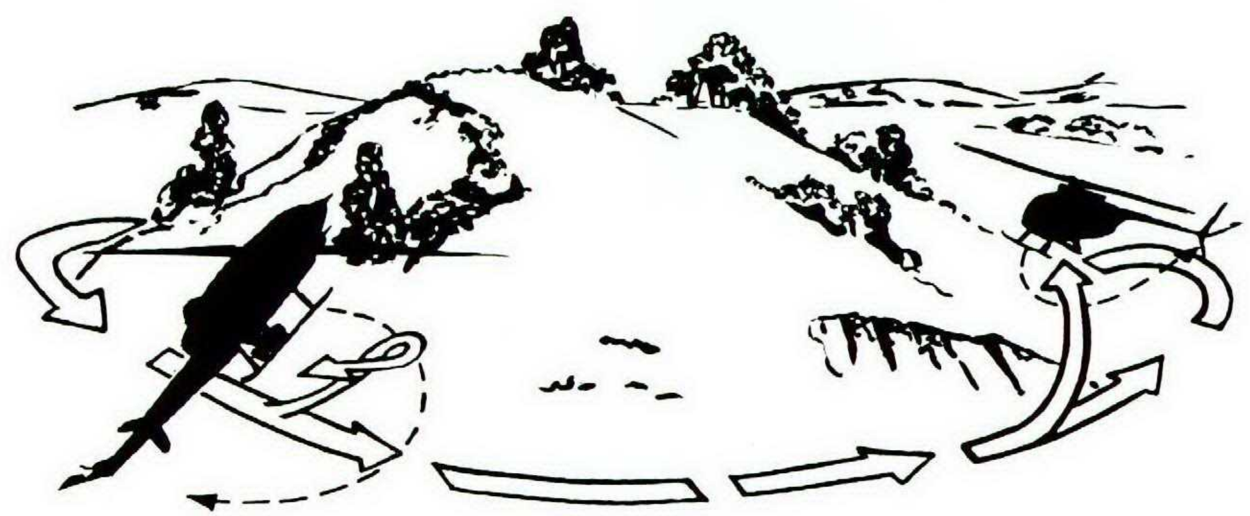


FIGURE 1

FIGURE 2

180° attack by HP enemy aircraft: Enemy aircraft rolling in to fire. Pink team takes evasive action.





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ing a container about the size of the average large attache case put together a kit to sustain this man indefinitely in the Arctic.

– now add to the same container those items required should the scene shift to the mid Atlantic

– now add any additional items required for the deserts of New Mexico.

Now, if this "adult male Canadian" were you – what would *you* want in that kit? Probably you would be inclined to ask – How long do I have to survive? – Crafty – you have come to the crux of the matter with lightning speed.

Previous experience has shown that in a Canadian context over 90% of all survivors have been rescued within four hours of their accident. In fact our longest term survivor in the past decade was in the boonies for a mere fourteen hours – so you might be inclined to cut down on the expensive goodies carried in our kits – but before you do – consider the possibility of a Tracker crash landing north of Goose Bay in a January storm. Can we virtually guarantee pickup within a day – not likely. What about a CF5 tanking across the Atlantic. Can we guarantee pickup in the event of an ejection? If not – lets not place too much emphasis on our previous experience which has generally been concentrated around our flying bases within a hundred or so miles of the American border.

That unfortunate crash – and several others besides – has caused us to question a decision which apparently was made in the early 1960s to provide Universal Survival Equipment. There was a trend in those days to the all singing all dancing – in everything. Unfortunately many of the products of that era have proven to be poor singers and rotten dancers – and now there is a return trend toward the mission oriented kit. If the mission is transatlantic, a boat seems a logical inclusion, and if the mission is in the high arctic a snow knife is appropriate. We have finally (I hope) learned to consult with two highly important groups of people First – the experts – available at our very own Survival School and Second – the potential users.

Oddly, until recently no one seemed very concerned with either of these groups. In some cases we bought equipment apparently because it looked good or because some salesman was able to talk us into it – but the experts could have told us that it was no good – and the users demonstrated their lack of faith in it by supplementing it on an individual basis. Check around your own unit and see what extra goodies your people are carrying with them. If they carry extra rations maybe its their quiet way of telling you that they haven't a lot of faith in our rescue organizations timely arrival capabilities. If they carry their own hunting knives maybe thats because they distrust the one they are issued. If they wear a bandolier maybe thats a sign that they have reason to expect to loose their seatpack. Look into these signs. They are important because one of the best things we can give our aircrews cannot be packed in any kit – it goes into the man himself – its called CONFIDENCE.

We have to make available to our men those items for which they perceive a need – even if they are mistaken – or, if for some reason (and it better be a good one) we cannot – we must explain our failure to do so.

Our brief journey into Survival Philosophy has shown us that we in the Life Support Equipment business have three basic areas of input.

1. CLOTHING – our crews must be provided with appropriate garb for the jobs they are required to carry out. It must be warm enough – but not too warm. It would be nice if it were fire resistant, and it would also be nice if it were water resistant. It should be camouflaged for combat purposes and highly visible for survival purposes. Are you beginning to see some problems?

2. SAFE ARRIVAL – what shall it profit a man if he has a super survival kit but his parachute fails to open when required? We want our man to be able to quickly get out of his parachute in case of water landing – but we don't want him to fall out accidentally. We want to provide footgear which will support his ankles in parachute landings, which will keep him warm and mobile winter and summer, wet and dry – and which don't cost an arm and a leg or decrease aircraft payload. We want our aviator to be able to cut a riser if need be – but we don't want him to cut himself to ribbons, or puncture his liferaft. Are you discovering more problems?

3. SURVIVAL – we need to provide the capability for signals, first aid, water and a liveable environment – anything more is gravy.

If you as an Aircrew Life Support Equipment Officer can clothe your men adequately, get them safely into the survival situation, and give them the wherewithall required – you will have earned your keep.

At the beginning of this diatribe I mentioned

ISOLATION, BASIC TOOLS, and KNOWLEDGE

We can combat the hazards of *Isolation* through instilling confidence in our men.

– confidence in their ability to live

– confidence in our ability and determination to find them and rescue them

Through study and with effective foresight we can provide the *basic tools* which they will require.

Through the provision of properly thought out organized and enforced (where necessary) training we can ensure that when required the survivor will possess the required levels of Knowledge.

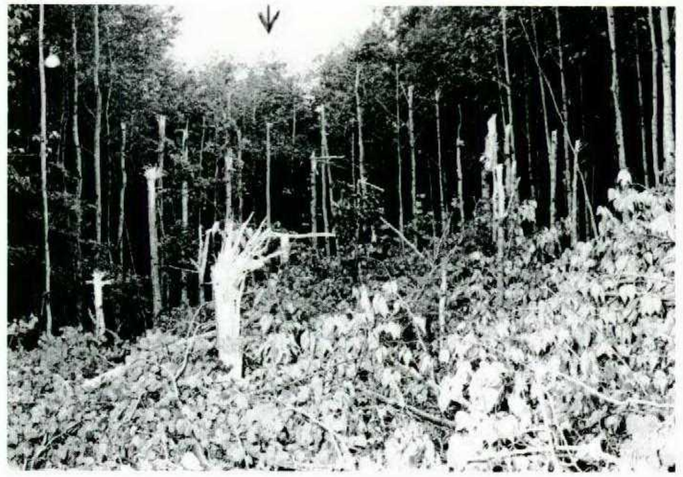
Now there are just two other things which I feel need mentioning in this little presentation – they are IMAGINATION and CREDIBILITY – and they are both extremely important in the ALSEO business.

First of all – we have to encourage forward thinking – even dreaming if you want to call a spade a spade – because without this – you're going nowhere. I'm talking about things like encapsulating liferafts which would actually enfold a flyer during his parachute descent – and support him – dry – when he reaches the water. I'm talking furthermore about a downed aircrew power source which would then provide heat for our sheltered boatsman – or cooling – whichever is required. I'm talking about a satellite communications system which will allow that warm, comfortable survivor to communicate with potential rescuers – anywhere in the world. Sounds farfetched I know – but all of this is presently being developed – and I bet we'll have it within a decade – because someone dared to dream – someone risked a little ridicule and faced down a lot of pessimism – and so we may get a good product.

I know this – and so do you – but it is important for our credibility that the troops in the field know that we are actively looking at everything that comes along with an eye to procuring it if it fills a need. Sure we aren't there yet – in fact we may never get there – but we are aiming at perfection – at guaranteed survival. We must impress our troops that we are well aware of all the advances made and being made by the RAF, the USAF, the US Navy – and virtually everyone else. When we decide *against* taking the same action – we must explain why – or our men will inevitably decide that we never looked – or worse – that we are blinded for one reason or another.

We are making an honest effort to provide the best possible chance for our aircrew to preserve that most precious of quantities – their lives. But just doing this in itself is not enough – we must *be seen* to be doing this. This should be a high profile activity – and we must all function as disciples or propagandists or whatever – selling our products, advertising our research, aiding in our developmental programs – and yes – criticising where this is required. It means a lot of work, it means minimal thanks or recognition – and often a lot of hassle – but LIFE SUPPORT is the name of the game – and there is simply NOTHING more important.

'Oscar Four' Crashes at Cold Lake



On 7 Jun 77, a flight of four CF5 aircraft using Callsign Oscar, took off from CFB Cold Lake to conduct a low level Ground Attack Tactical mission. Approximately seven minutes after take-off, Oscar 3 experienced a right engine fire warning indication and was escorted back to base by Oscar 4. Oscar 1 and 2 continued the mission as briefed. After ensuring that Oscar 3 was safely on the ground, it appears that Oscar 4 began to backtrack the planned route with the intention of either rejoining the formation or executing an intercept.

At approximately 2240Z Oscars 1 and 2 were at 500 feet above ground and called a visual contact on an aircraft in their 12 o'clock position. This call was acknowledged by Oscar 4 who then initiated a stern attack on Oscars 1 and 2. Oscars 1 and 2 evaded the attack by separating and climbing. The attack and defensive manoeuvres were terminated at between 7,000 and 9,000 feet above ground level. At this time Oscar 2 saw Oscar 4 behind and below him in a steep descending turn. Approximately five seconds later Oscar 4 hit the ground.

The aircraft hit small trees while in an exaggerated nose up attitude with a high sink rate. The aircraft wreckage was spread over a distance of 530 feet with the left engine being the furthest component from the point of impact. Fire damage was extensive to all parts of the aircraft with exception of the engines.

Investigation of the engines indicates a high power setting at impact. The flight controls appear to have been serviceable. The fuel state is estimated at 3,000-3,500 pounds at the time of the accident. There is also evidence that the wing flaps were in transition between the full up and full down position.

The pilot made no attempt to eject, which probably indicates that he was making every effort to avoid striking the ground right up to the last second. Because he was apparently controlling the aircraft during the sequence of events leading up to the impact, incapacitation seems unlikely as a cause.

Oscar 4 had executed a low level intercept on Oscars 1 and 2. The intercept was successfully negated by Oscars 1 and 2 using standard, approved defensive manoeuvres. Oscar 4 then commenced a hard descending right turn. While attempting to recover from this turn the aircraft hit the ground.

Back to Basics

An aircraft was flown on a pilot currency sortie. During stalling practice, at a nose high attitude and low airspeed, the aircraft's wing dropped. The student pilot used aileron in attempting to pick up the dropped wing, so the aircraft spun. Recovery was effected 6300 feet lower. The aircraft was checked and found to be correctly rigged.

Another aircraft crashed recently, killing the three occupants. Various facts indicate that the aircraft departed controlled flight during an approach to the stall, and that the crew was unable to retrieve the situation.

During flight training, students are immersed in the basics of flight. They understand, and apply daily, the basic aerodynamic laws which govern controlled flight. Under supervision, they fly out to the fringes of the aircraft's performance envelope, and come back to reflect on their new found knowledge and enrich their growing fund of experience. Then they leave flight school.

Some students go on to fly aircraft in operations which continue to expose them to all parameters of their aircraft's performance. They continue to build up their data bank on maneuvering flight, and so live easily with its demands. Those who go from UPT to transport operations discover a restrictive flight profile. Without physical exposure, they run the risk (dare I say it?) of forgetting an important few of those facts necessary to fly an aircraft safely in extreme maneuvering flight. Now, should these pilots be unexpectedly exposed to the grey areas of the grey areas of the flight envelope, it's like facing Mohammed Ali with a glint in his eye.

For all those reading who can instinctively and correctly apply the timely actions necessary to recover from the approaching stall or incipient spin-good for you. May you continue to remember them so well each time you fly, and may you never have to use them in anger.

For those who are a little vague — just a little — about stall and spin recoveries — let's get into the books, and illuminate these dark corners of our minds. We should:

A. Know the symptoms,
B. Know the correct recoveries, so we can
C. Avoid the symptoms, and hopefully,
D. Avoid having to use the recoveries.

With these actions continually fresh in our minds, we can approach low speed operations more confidently, more safely, and more professionally.

by Sq Ldr Perrett

Comments to the editor

Dear Sir:

In your Edition 5, 1976, you comment on two fatal accidents, Hawk 4 at Comox and Tutor 028 at Regina. Each of these pieces precipitated thoughts in my mind and I submit them for what they are worth.

Regarding the Voodoo prang, I was reminded of a tragedy of which I have only distant memories and verbal reports. Some years ago an ex-service pilot was demonstrating low level aerobatics for the press in a civilian Chipmunk. He was carrying a photographer in the back seat who no doubt was encumbered by cameras, etc. The aircraft failed to recover from a steep descent and the way I heard it the cause was a camera which had fallen to the floor and lodged between the control column and the rear seat. The stick could not be moved back and the descent continued until impact. Could there be any parallel between that prang and Hawk 4?

In your report on the Tutor crash you allude to the possibility of not devoting enough thought to forced landing the Tutor. I only have about five Tutor trips, all flown crica 1964, so I claim no expertise in handling the beast, but I do remember some of the Canadair sales brochure material. I recall that the Tutor was supposed to be built around two ski-like floor members under the cockpit which were to be braced by surrounding fuselage structure to form a sort of sled. The idea was that it possessed a phenomenal "G" tolerance and provided very effective protection to the crew in a wheels-up forced landing. I have been quite surprised over the years to hear of the number of bail-outs in Tutors versus the number of forced landings. The contrast between this and the multitude of successful belly flops done in Harvards is startling. The landing speeds are comparatively close and in the Yellow Peril you bashed up a propeller and slid along on your fuel tanks!

Have we been guilty of trying to train pilots to fly their next aeroplane instead of their present one?

G.B. Bennett
Major
Acting BFSO, CFB Summerside

Comments

This edition of Flight Comment is dedicated to Colonel R.D. Schultz, whose photograph and wise counsel appeared on this page for over a decade.

As most of our readers will long since have realized there is symbolism as well as beauty on our front cover. The Mosquito night fighter pictured is a re-creation of one flown by Colonel Schultz, the retiring Director of Flight Safety, during World War Two, while the Voodoo is a replica of "his" aircraft when he was setting up the original CF-101 OTU. We hope that in both cases the accuracy of the drawings is acceptable — particularly since throughout his career "The Colonel" has been a real stickler for detail. The original oil painting was presented to Colonel Schultz at his retirement mess dinner.

More than half of all the pilots currently flying in the Canadian Armed Forces have flown throughout their careers under the watchful eyes of Colonel Schultz. Many of us have had dealings with him on either a professional or a social basis, or both, and virtually all of us have come to respect and admire him greatly.

Those who have worked closely with him recognize perhaps better than others his utter dedication to flight safety — to preserving our resources, both human and mechanical, for the day when they might be required operationally. Anything else is rubbish — and that is something which Colonel Schultz was never reluctant to point out. After ten years in harness at DFS he never once has exhibited a tendency to slow down or sit back and rest on his laurels. His integrity is absolute, his loyalty to the service is without equal, and his concrete accomplishments over a career spanning more than three and one half decades are without parallel.

When all the mess dinners and retirement testimonials are over, when the crackle of Rolls Royce Merlins is joined in memory with the whine of Orendas and the roar of J57s, those of us who weren't even born when Joe Schultz was carving contrails over the English Channel will be able to say of him to our sons and daughters — "Now there — is a man."

NATIONAL DEFENCE HEADQUARTERS
DIRECTORATE OF FLIGHT SAFETY

COL R.D. SCHULTZ
DIRECTOR OF FLIGHT SAFETY

MAJ D.H. GREGORY — Education and analysis
L. COL. J.R. CHISHOLM — Investigation and prevention

Editor: Capt John D. Williams
Graphic Design: Mr. John Dubord
Art & Layout: DDDS 7 Graphic Arts
Office Manager: Mrs. D.M. Beaudoin

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Replacing Colonel Schultz as Director of Flight Safety will be easy in one sense because he has left behind a well established and highly effective organization manned by a very professional group of people. Unfortunately, it won't be easy to maintain the very high standards which he set or to achieve the personal credibility which he had.

Maintaining these standards is important but we must not forget that Flight Safety is not an entity in itself but rather an integral part of the whole operation.The responsibility for safety still rests with those who supervise and manage our aviation resources and those of us in Flight Safety are simply part of the team. Having a trained Flight Safety organization is an important management tool which should have the time and expertise to detect weaknesses in the system and to offer solutions to problems.

The accident rate this year has taken an upward trend which is serious but not alarming. What is obvious is the fact that to maintain a rate below one per 10,000 flying hours is an increasingly difficult task. It has also been apparent for some time to everyone in the Flight Safety business that we are not too successful at preventing human error accidents. Consequently, DFS is going to expend a lot of energy in the near future in trying to find ways to counteract this problem.

I have no illusions about the role of Flight Safety. It might be considered a necessary evil. Some consider it a peacetime luxury which dangerously hinders their efforts to conduct realistic training. Too often that rationale is simply an excuse to hide an unnecessarily hazardous operation. Certain types of military flying are inherently hazardous and once this is recognized the risks can be minimized. The accidental loss of aircraft and personnel due to unprofessional behaviour can never be condoned. The function of our accident prevention programme is to find out why accidents happen and to avoid making the same mistakes over and over again.

Enough moralizing. The next few years will present a real challenge to those of us who must manage, operate and support military aviation in the Canadian Forces. We are familiar with the problems associated with our present aging fleet and this won't get easier. Our new aircraft will be technologically superior and likely easier to operate and maintain. What will change is the increasing value of the equipment, the high cost of operation and the decreasing experience levels of our personnel. I can assure you that we in Flight Safety intend to do our part of the job.

COL. J.R. CHISHOLM
DIRECTOR OF FLIGHT SAFETY

Succéder au colonel Schultz comme directeur de la Sécurité du Vol sera, dans un sens, une tâche assez facile car il a laissé derrière lui une organisation solide et efficace, avec l'aide d'un groupe d'experts dont la compétence n'est plus à démontrer.

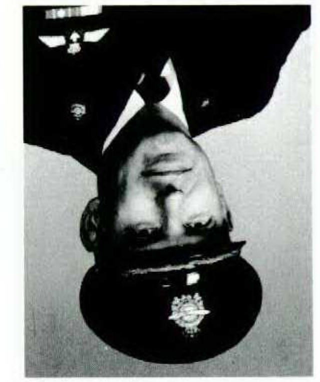
Par ailleurs, il sera difficile de maintenir un tel degré d'excellence et d'atteindre le niveau de crédibilité qu'il a obtenu.

Cependant, il est important de ne pas oublier que "Flight Safety" n'est qu'une partie intégrante d'une organisation considérable. La responsabilité pour la sécurité repose encore sur ceux qui dirigent et surveillent nos ressources en aviation et nous, dans "Flight Safety", ne sommes qu'une partie d'une équipe.

Avoir une organisation bien formée est un facteur important pour déceler les faiblesses du système et pour offrir des solutions aux problèmes.

Cette année, le taux d'accidents, a une tendance à être plus élevé, mais il est évident que, pour garder un taux plus bas que 1 pour 10,000 heures de vol, celà devient de plus en plus difficile. Il est apparent aussi que nous, dans "Flight Safety", n'avons pas beaucoup de succès pour prévenir les accidents qui sont causés par des fautes d'inattention, de jugement ou d'étourderie. Par conséquent, DFS a l'intention de déployer un effort énorme pour enrayer ce problème.

Je n'ai pas d'illusions concernant le rôle de "Flight Safety". Quelques-uns le considèrent comme un luxe en temps de paix, ce qui gêne dangereusement leurs efforts pour diriger un entraînement effectif. Trop souvent, ce raisonnement est simplement une excuse pour cacher une opération hasardeuse qui en plus n'était pas nécessaire. La perte accidentelle d'un avion ou d'un individu causée par une façon d'agir non-professionnelle n'est sûrement pas à approuver. La fonction de notre programme pour la prévention d'accidents est de trouver pourquoi un accident est arrivé et aussi afin d'éviter que les mêmes erreurs se produisent de nouveau.



Celà suffit . . . Ne faisons plus la morale! Les prochaines années présenteront un réel défi pour ceux qui dirigent, opèrent et supportent l'aviation militaire dans les Forces canadiennes. Nous connaissons les problèmes associés à notre présente flotte vieillissante et ceux-ci ne deviendront pas moins difficiles. Nos nouveaux avions seront technologiquement supérieurs et probablement plus facile à opérer et à entretenir. Ce qui va changer c'est l'augmentation de la valeur de l'équipement, le coût élevé des opérations et la diminution du niveau d'expérience de notre personnel. Je puis vous assurer que nous, à "Flight Safety" avons l'intention de faire notre part pour réaliser ce défi.

COL. J.R. CHISHOLM
DIRECTEUR DE LA SÉCURITÉ DU VOL