RCAF

FLIGHT COMMENT

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FLIGHT COMMENT

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ROYAL CANADIAN AIR FORCE
DIRECTORATE OF FLIGHT SAFETY

For the past few years, the accident rate in the RCAF has gone steadily downward. This gives us reason to believe that our vigorous flying safety program is paying welcome dividends; but it does not give us cause to be complacent, nor to be satisfied with the results to date. We can never let up on our flight safety program. However, the downward trend is encouraging, particularly in the light of the complexity and speed of new aircraft that we have brought into service in recent years.

There are very good reasons for pursuing a systematic and intelligent safety program. We must do everything that we possibly can to safeguard the lives and well-being of aircrews and passengers. We cannot afford to expend human lives. Nor can we afford the loss of aircraft that are both difficult and expensive to replace. Every loss, every unserviceability attributable to an accident, weakens our operational effectiveness and lowers our contribution to the security of Canada. For these reasons alone, it is mandatory that we work diligently to remove the causes of accidents.

Every precaution is being taken by contractors and manufacturers to ensure the mechanical and structural soundness of aircraft and parts, and our quality control experts and aircraft inspectors check and recheck the products destined for our use. In this way, we are eliminating conditions that might give rise to accidents at a later date. We have extended careful supervision and inspection to all of our own maintenance operations to ferret out incipient weaknesses. And, of course, we have exerted every effort to impressing upon everyone—aircrew and groundcrew alike—the need to observe all rules and regulations pertaining to the conduct of flight.

Yet we still have accidents. Very few of these have mechanical failure as a primary cause. Most of them can be attributed to human error somewhere along the line. Human error is difficult to eliminate. It will probably always be with us in varying degrees; but we can reduce it substantially through knowledge and its application to the job at hand. The complexity of modern aircraft demands greater skills in maintenance and flying—skills that can be exercised safely and judiciously as a result of knowledge. I ask everyone associated with flight to acquaint himself thoroughly with his aircraft, with its systems and all associated equipment, and with its capabilities and limitations. The knowledge so derived will help to reduce error and prevent accidents.

I wish to commend all members of the RCAF on the success so far achieved in our flying safety program. At the same time, I wish to put forth the reminder that only through continuous effort and vigilance can we reduce our accident rate still further in 1963.

(C. R. Dunlap)
Air Marshal
Chief of the Air Staff

Liferaft Inflation

F/L D. E. WRIGHT

The inflation of a liferaft boils down to a simple physical action - a sharp pull on a lanyard or "T" handle, or a flick of an electrical switch which in turn trips a release mechanism in the operating head of a gas cylinder. This action is the same whether you are standing high and dry in a safety equipment section, scrambling from a ditched aircraft, or up to your neck in water with a seat pack floating in front of you.

There are many types of liferafts, each designed to suit the aircraft in which they are carried, but they are all inflated by releasing a gas from a pressurized cylinder. The RCAF uses carbon dioxide.

A desirable characteristic of carbon dioxide is the ease with which it can be liquified and stored at low pressures below a temperature of 88°F. A cylinder volume of 0.34 cubic feet can be filled with 11.26 pounds of carbon dioxide, sufficient to inflate a twenty man liferaft with 88 cubic feet of buoyancy chamber to a pressure of 1-3/4 psi at 70°F. During the charging process, once the gas pressure in the cylinder reaches the vapour pressure of carbon dioxide corresponding to the gas temperature, carbon dioxide condensate is formed and fills the cylinder at constant pressure as more gas is forced in. The cylinder is designed to contain the required weight of carbon dioxide when approximately two-thirds of the volume is filled with liquid. At 70°F the internal pressure, or vapour pressure, is 852 psi and at -40°F, 145 psi. It is this internal pressure that forces the carbon dioxide into the liferaft.

The cylinder assembly is equipped with a flexible syphon tube so that the liquid carbon dioxide is forced out first. As the liquid passes into the region of the lower pressure in the operating head and hose connecting the cylinder to the liferaft, it evaporates to the gas phase and then expands as it passes into the region of low pressure in the liferaft buoyancy chamber. Both these processes - evaporation and expansion - require heat. Unfortunately, the transfer of heat from the surrounding medium cannot keep up with the heat requirement and the temperature of the carbon dioxide is lowered. If you have witnessed a liferaft inflation out of water you perhaps noticed how cold the liferaft fabric felt and saw the frost form on the cylinder and adjacent buoyancy tube.

At atmospheric pressure and -110°F, carbon dioxide will change from a gas to the solid phase, commonly referred to as dry ice. If the initial temperature of the system is low, the heat taken up by the evaporation and expansion processes will lower the carbon dioxide

The author, F/L D. E. Wright, is a research and development engineer at the Institute of Aviation Medicine, Toronto. A graduate from RMC and the University of Toronto, he joined the Air Force in June 1958, at Chatham, N.B. as an aircraft repair officer. He was promoted to Flight Lieutenant in July 1960 and has been in his present position since September 1960.

temperature to the point at which dry ice will form. The amount of gas available for inflation is reduced and in some cases the dry ice can block the plumbing and trap most of the carbon dioxide in the cylinder.

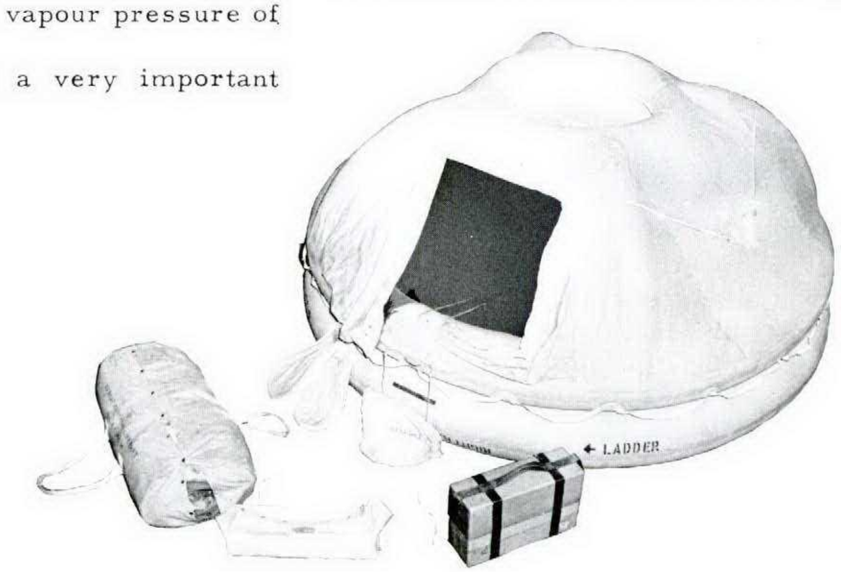
In a controlled laboratory test out of water, a liferaft which will inflate quickly at 60°F can be rendered useless by cold soaking it at -40°F for five hours. The effects of heat loss from the carbon dioxide-loss of gas pressure in the liferaft, the formation of dry ice, and the lack of pressure in the cylinder to clear the blockage, compromises the inflation of a cold soaked liferaft.

Recommendations for the correction of poor inflations resulted from a study conducted at the Institute of Aviation Medicine in which multi place liferafts equipped with various charges were cold soaked to temperatures of the order of -40°F. The recommendation was made that more carbon dioxide be used to inflate a given liferaft and the cylinder be charged with nitrogen gas as well as carbon dioxide. The extra weight of carbon dioxide merely increases the pressure in the fixed liferaft volume at low temperature and even though dry ice forms there is enough gas for inflation. Since nitrogen cannot be liquified above a temperature of -232°F and temperatures of this order do not exist in the sphere of aircraft operation, it will always be a gas and its pressure will be instrumental in forcing the liquid carbon dioxide from the cylinder in spite of any dry ice blockage. To illustrate the effect of adding nitrogen, practical cylinder pressure measurements reveal that a 615 cubic inch cylinder containing a 14 pound carbon dioxide and 400 psi nitrogen charge has an internal pressure of 1475 psi at 70°F. At -40°F the pressure is 594 psi, 449 psi higher than the 145 psi vapour pressure of carbon dioxide.

The study brought out a very important aspect of liferaft inflation that has not yet entered this discussion - the influence of water. Water transfers heat to the evaporation and expansion processes at a much faster rate than air, and while the inflation of a normally charged cold soaked liferaft may be unsuccessful out of water, it will inflate and be boardable in water. Why then are we going to the trouble of adding more carbon dioxide and nitrogen? In the first place even though liferaft inflation will be successful in water, the additional gas charge is a measure of insurance that the liferaft will be inflated in as short a time as possible, and secondly, the liferaft must be capable of inflating sufficiently to force itself out of the liferaft wing stowage and be in a condition suitable for launching by the survivors without relying on the warming influence of water.

The ultimate in liferaft inflation is a controlled chemical reaction which will supply the correct amount of gas to inflate the liferaft at any temperature. The carbon dioxide and nitrogen caters to low temperature conditions. In high temperatures this system produces more inflation gas than is necessary and the excess pressure imposes a load on the pressure relief valves. The chemical reaction system can be made to produce only the amount of gas required to bring the liferaft up to operating pressure. At the present time the problem is the method of controlling the rate of the reaction and the dissipation of heat produced.

New inflation systems are currently in the development stage and until they prove as reliable and are put into service, we will continue to use the carbon dioxide and nitrogen system - and it can be used with confidence.



F/L H. A. ROSE


F/L N. G. GILLESPIE


F/O J. H. TAYLOR

Three pilots, F/L H.A. Rose, F/L N.G. Gillespie, and F/O J.H. Taylor recently experienced similar emergencies which were professionaly handled by the pilots and the support personnel of their respective stations. The three aircraft involved, a T33 and two Sabres, were landed with minimum damage.

F/L H. A. ROSE

Perhaps, the more spectacular of the three incidents occurred at Station Chatham where F/L H.A. Rose, flying a Sabre, found himself in the unfortunate position of having the nose and starboard wheels down and locked but the port wheel firmly tucked up in its well. After considerable effort by the pilot and after trying all suggestions of ground personnel a combined decision to land the aircraft was made. Complicating this decision was a low fuel state; the return for landing of several other aircraft, some of which were also low on fuel; and airfield construction, which only permitted the use of one runway.

Aircraft in the area which had sufficient fuel were diverted. Equipment was quickly organized and positioned, and while a foam strip was being laid the pilot was briefed. With professional and accurate flying F/L Rose landed his Sabre on the nose and starboard wheels and with the port drop tank on the strip of foam. The ground organization and equipment then moved in, the aircraft was removed, and the runway cleared and the other aircraft recovered just twelve minutes after touchdown of the disabled Sabre.

The total damage—a scraped drop tank.

The undercarriage malfunction was caused by loose linkage bolts in the door lock hooks causing the linkage to bind and preventing hooks from releasing.

F/O J. H. TAYLOR

At 3 Wing F/O J.H. Taylor was approaching to land as #2 of a section when he was informed by his section lead that his nosewheel was cocked approximately 60 degrees to starboard. Combining with ground personnel all possible procedures were tried with negative results. A foam strip was quickly laid and the aircraft landed with the nose gear on the foam with no further damage.

Investigation revealed that the nosegear rotation mechanism oleo lever link had sheared when the gear selection was made allowing the nosewheel to remain in the cocked position. The incident was assessed as Materiel with the cause obscure.

F/L N. G. GILLESPIE

On takeoff in a T33 from the Lakehead, F/L N.G. Gillespie noted an unsafe condition of the nose gear. Quick observation by the tower confirmed the nose gear hanging 45 degrees and the wheel cocked 45 degrees. Recycling the gear failed to rectify this condition.

Weather and other factors precluded a landing at Lakehead and due to runway construction at Winnipeg, a decision was made to land at Portage. A clearance was obtained at an altitude where a reasonable TAS could be obtained for the low IAS required for this condition and for the best fuel consumption. The aircraft headed for Portage and enroute through ATC facilities, Portage was kept informed of developments. On arrival he found an alert station with technical, flying and support personnel ready with advice and assistance. All efforts to straighten nose gear were unsuccessful and the aircraft was landed with the cocked nosewheel on a quickly laid foam strip.

The aircraft could not be stopped in time and ran off the end of the foam strip and swerved into the infield. Fortunately, at such a low speed no damage was caused.

A technical malfunction caused the cocked nosewheel.

In these three cases, the professional approach and skill of the pilots and the co-operation and quick reaction of station personnel are deserving of a Good Show.

LAC J. H. C. BRODEUR

LAC M. RESHNICK

Two airmen, LAC M. Reshnick and LAC J.H.C. Brodeur from 440 (AW) Squadron, Baden-Soellingen, Germany, are deserving a Good Show for their quick assessment of a potentially dangerous situation, their knowledge of the aircraft and the location of the correct fire extinguisher.

The two airmen were assigned to marshall a CF100 aircraft into the 440 Squadron dispersal at 4(F) Wing. When the pilot set the parking brake, hydraulic fluid suddenly escaped under pressure from a fractured line attached to the Maxaret unit on the starboard wheel. As the fluid came into contact with the hot brake, an intense fire started immediately and flames roared up into the wheel well.

The quick and correct reaction of these airmen succeeded in extinguishing the fire and preventing greater damage to, or the possible loss of an aircraft.

A WORD TO THE WISE

Floyd Carlson
Chief Pilot
Bell Helicopter Corp.

What would you do if the helicopter you are flying should suddenly develop serious mechanical difficulty?

With no sound emergency procedure already in mind, you're apt to "panic" and in the crucial moments to follow, perhaps do the very opposite of what you should to avoid disaster.

The need for helicopter pilots to establish a sound emergency procedure to be followed in event of sudden mechanical difficulty cannot be stressed too much. Because no matter how well your machine seems to be operating, nor how carefully and conscientiously you maintain it, there are always hidden possibilities of human error, unforeseen circumstances, inadvertent damage to parts, etc.

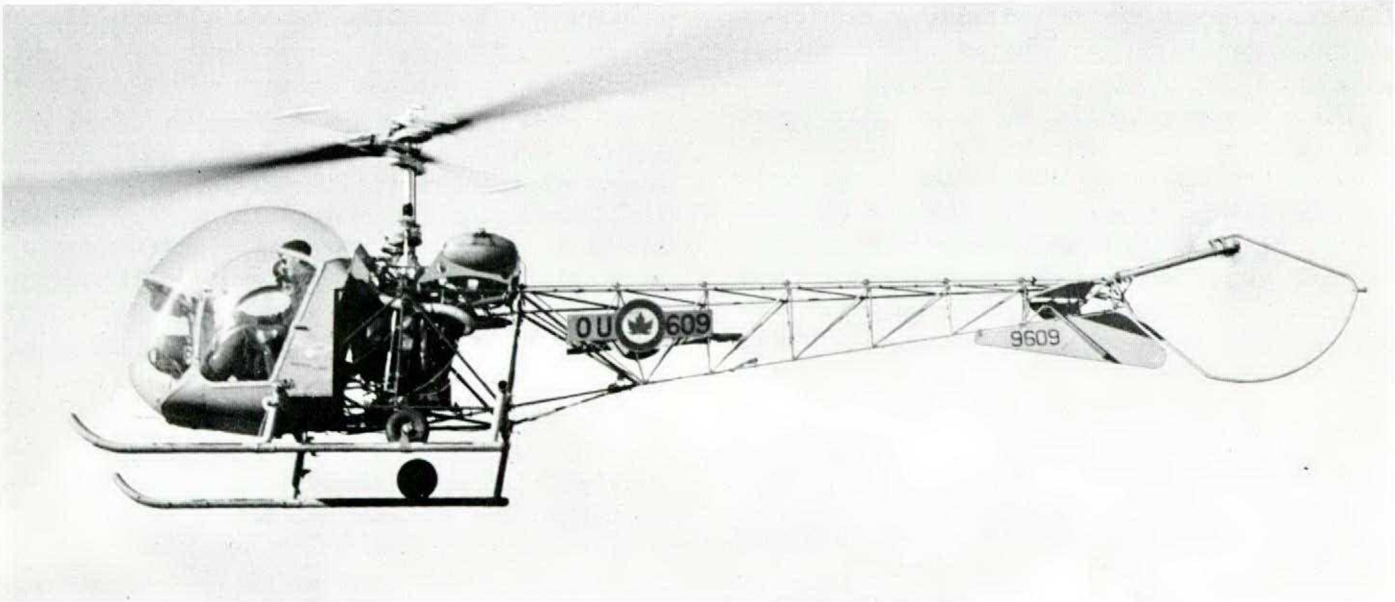
It is easy to be lulled into a sense of security by a consistently smooth-operating machine. It is equally easy to develop habits of safety which will allow you to automatically cope with any freak situation which might suddenly arise.

It is my firm opinion that if a failure occurs which the pilot recognizes by change in noise level or sudden lurching, in most cases the proper procedure to follow is reduction of power immediately to the extent of placing the helicopter in autorotation.

The necessity for the pilot to follow this procedure instantly in event of tail rotor failure or tail rotor drive failure cannot be over-emphasized. This procedure is the proper one to follow in case of most other failures too—including fan or engine malfunction or fire.

If, after you have placed the craft into autorotation, you have been able to analyze the difficulties experienced, it may be possible that some power or full power can be applied. For example, in event of fan belt failure, the flight could be continued, if necessary, to a more suitable landing area.

From the above, you can see the importance of keeping your hand near the throttle at all times. In event of any sudden change in the helicopter's noise level or change in its handling characteristics, get the power off immedi-



ately. Once you have done this and are in autorotation, analyze the situation and try to determine the problem area by feeling the control responses, checking engine instruments, etc.

In normal cruise flight, it is recognized that your hands have to be used for other things such as radio tuning and handling maps. However, the pilot should remember that he may have to come back to his collective and throttle control very quickly in event of emergency. It also is recommended that at least 800 feet of altitude be maintained while these duties are being accomplished so as to allow a safe margin of manoeuvering.

To go more into detail on what is experienced when tail rotor drive or tail rotor failure occurs, let me pass on this information to you:

Most helicopters when flying in rearward flight at speeds exceeding 20 mph will pitch nose down at a fairly rapid rate. The rate of pitching is a function of the rearward airspeed; higher the rearward airspeed, higher will be the rate of pitching.

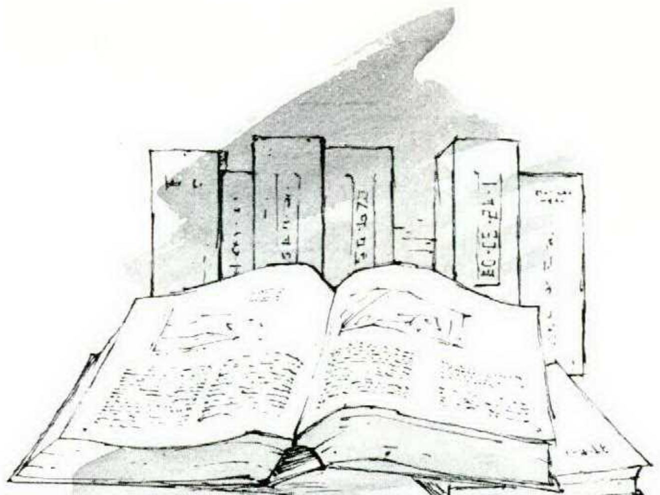
High rearward airspeeds may be obtained as a result of excessive yawing which follows a loss in directional control during cruise flight. The resultant nose down pitching also may be aggravated by forward center of gravity location. Therefore, in event of tail rotor control loss, it is readily seen that you must remove the torque being supplied by the engine to keep the torque from rotating the fuselage yawing in a manner to put the helicopter into high rearward flight speeds.

From discussing this with a number of helicopter pilots, I have the impression that many pilots have the idea that the tail boom plus the ventral fin would supply sufficient directional stability at cruise speeds to the extent that the pilot would only experience a few degrees yaw while at cruise speed and cruise power. This definitely is not so.

While the tail rotor either slows down or is lost completely, appreciable effective fin area is lost. The loss of directional control at zero airspeed may not result in excessive nose down pitching—however, again, power reduction is mandatory to limit hovering turning rate.

While in autorotation, the tail boom, as well as the ventral fin, give adequate directional stability so that a normal autorotation landing can be accomplished. Turns may be accomplished by normal use of lateral cyclic control.

USN: Approach



No Routine Maintenance

When a worker becomes thoroughly familiar with his job, regardless of its complexity and significance, he may tend to lose some of the caution and precision with which he first approached it. Hence, the experienced maintenance man, good at his job and almost always right, may tend to rely too much on his memory instead of using EOs, checklists, and other aids. Or he may, because it has become fairly routine, try to do a job too quickly to give it the full attention it deserves. He can thus slip up on an important detail and inadvertently become the major factor in an accident.

Keeping out of the workshop unintentional neglect due to familiarity is an important job of the maintenance supervisor. From his overall vantage point he should be able to see when laxness may be creeping in and so take action to eliminate it. He must insist that all personnel—regardless of experience—use current EOs and handbooks, particularly when the job is important and involves a variety of complicated actions. If his men lack the type or degree of qualification required to turn out a tip-top maintenance job, he should arrange for appropriate training.

Maintenance is intended to preserve; don't let it contribute to accidents instead.

TIG "Briefs"

Let It Be Clearly Understood

At some time or other in our lives we experience situations which develop because of a misunderstanding. Sometimes these can be humourous, sometimes serious, and sometimes, in our profession, disastrous.

Why do people misunderstand? There are many reasons: poor explanation, lack of concentration, poor communications, insufficient basic knowledge and sometimes a fundamental difference in outlook that leads to complete and utter confusion. How often do we hear the expressions "I thought you meant", "I thought he meant", "they thought he meant" etc. Although in the majority of cases no harm is done, in some cases, however, considerable harm and even tragic accidents result.

It is facinating to watch the bidding at an auction sale of expensive art. As the bidding goes on, small, almost imperceptible movements of the bidders convey a message to the auctioneer. Thousands of dollars, and even millions, may rest on the blink of an eye. The auctioneer and bidders are experts, specialists in a profession where a misunderstanding could mean great financial loss. The stakes are high; the competition intense; the feeble are left behind and only the very best survive.

We have the same situation in the RCAF. Our personnel are professionals. The cost of aircraft and equipment is staggering. When a CO operates his station he is running a multi-million dollar establishment. Capital cost of a CF101 squadron, for example, is around $20,000,000. This is only part of the picture. Lives of men, training requirements and the defence of our country are all combined in a closely knit organization that depends on many sections working smoothly together. Misunderstanding has no place in this picture!

The focus of our attention and our maximum effort to prevent misunderstanding must be in the technical and operating spheres. This is not an attempt to belittle other trades and workers, but obviously an error which can be corrected by a pencil, or issuing another set of blankets or setting another place at the table is not to be compared to an error that might well result in the loss of human life or a million-dollar aeroplane.

To sum up our thinking then—let it be clearly understood that:

- Briefings must be complete, detailed, and not rushed or interrupted.
- Supervisors must make their position clear, nothing less than perfection should satisfy them.
- Technicians must be completely familiar with all the EOs and pertinent instructions governing the equipment which they service or operate—and must follow those instructions. Only in exceptional circumstances, to be decided by the highest service authority, will safety of an operation be allocated second priority.
- Personnel, both air and ground, who have a direct connection with flight safety must meet all the criteria of training, and have the ability and the proper attitude.

MAINTAINING VFR DURING PRACTICE GCA

Pilots occasionally have passed through low scud or fog while conducting GCA practice runs under VFR conditions. Even if a pilot is controlled by GCA he must remain VFR if he is filed VFR. If VFR cannot be maintained the pilot should remain clear of the scud or fog advising GCA of his actions and intentions.

USN: Approach

The Code of the Pilot

"Ethics are instilled by example and by experience".

The choice is yours. You are committed to the profession of piloting aircraft with all the challenges and rewards that this implies and the obligations that you have accepted.

The meaning of "profession" according to the dictionary is a "vocation requiring knowledge of some department of learning or science." This is only a partial definition because we are concerned with professional attitudes as well as professional knowledge.

For the purpose of this discussion, we can define a "professional" as one who has mastered the knowledge required for his vocation and, in addition, is required to use independent judgement in exercising his knowledge. The aircraft pilot certainly meets this definition. He must have a specific type of knowledge; he must be able to analyze situations in the light of his knowledge and arrive at reasoned decisions on the basis of personal integrity.

Integrity is essential to professional conduct. When you visit a doctor for medical attention, when you seek the services of an engineer or architect for advice on the construction of a house, when you retain a lawyer to help in drawing a will or for other legal advice, you are placing your safety or welfare in the hands of a professional person. Where the practitioner of these various professions has established a reputation for integrity, he commands your confidence. Your selection is made on the basis of his integrity because your own knowledge is not adequate to judge the value and correctness of his advice.

His integrity and your confidence in his judgement are based on:

1. High standards required to qualify for his profession, calling for thorough educational and training process.
2. Maintenance of his proficiency; keeping abreast of new knowledge.
3. Recognition of his professional status by others who are qualified to evaluate his work.
4. A tradition of individual responsibility, of intellectual curiosity and activity, of service to individuals and to society.
5. Ethical standards of conduct, self-imposed, established by the profession. This means that he must always be critical of his own acts and his competence in relation to those he serves or with whom he works.

Professionalism means to know your occupation so thoroughly and intimately that it becomes a part of your life. You feel you will never know enough about it, so you seek constantly to improve your knowledge and proficiency. In short, you wish to become a master of your profession.

Piloting modern aircraft in the service of your country, or of its citizens, has every element common to other professions.

Flying is becoming ever more exacting, requiring strict compliance with proven good practice, careful attention to detail, continuous alertness. A pilot must keep abreast of new techniques and new procedures just as the doctor, the engineer or the lawyer. As in other professions, his technical competence must also be coupled with integrity else he becomes discredited.

In several respects, military and transport piloting is a more exacting profession than the others. No other profession is subject to such frequent proficiency checks. Because of the precarious nature of his activity and his constant battle with the law of gravity, the aircraft pilot must be continually alert to any form of over-confidence, complacency, egoism, vanity, irresponsibility and impatience. In these respects, he has much in common with other professional people who deal with the safety or welfare of the public. They must also guard against the same weaknesses; however, a pilot bears a unique additional responsibility because often no other "expert" is around to check his judgement and his action at the time he makes them. No other profession requires such a combination of skill, judgement, art, with ever-changing techniques which must be mastered and the whole used in such a short allowable time.

The pilot carries high responsibility for the safety of the public just as do the other professions. The military pilot carries an additional moral responsibility--the preservation of a society.

The pilot meets every one of the demands of other professions except one.

Unlike other and older professions, pilots as a whole have not developed a written code of ethics. The doctor has his Oath of Hippocrates; the engineer, his Cannon of Ethics; the lawyer also has his Cannon of Legal Ethics. And now the aviation mechanic has a Mechanic's Creed.

A code is useful to professional people even though it may occasionally be honored in the breach because it acts as a rallying point about which members of the profession can gather to measure their competence, to uphold their integrity and to confirm their importance to society. It spurs professional progress on a high plane of activity. It creates a climate which induces high respect from the public at large, and it acts as a guide to conduct which neither legal decrees nor military dictums can supplant.

A code of ethics rests on the voluntary acceptance of basic principles of conduct by group acquiescence.

An examination of the codes, cannons and creeds of other professions shows that they have these points in common:

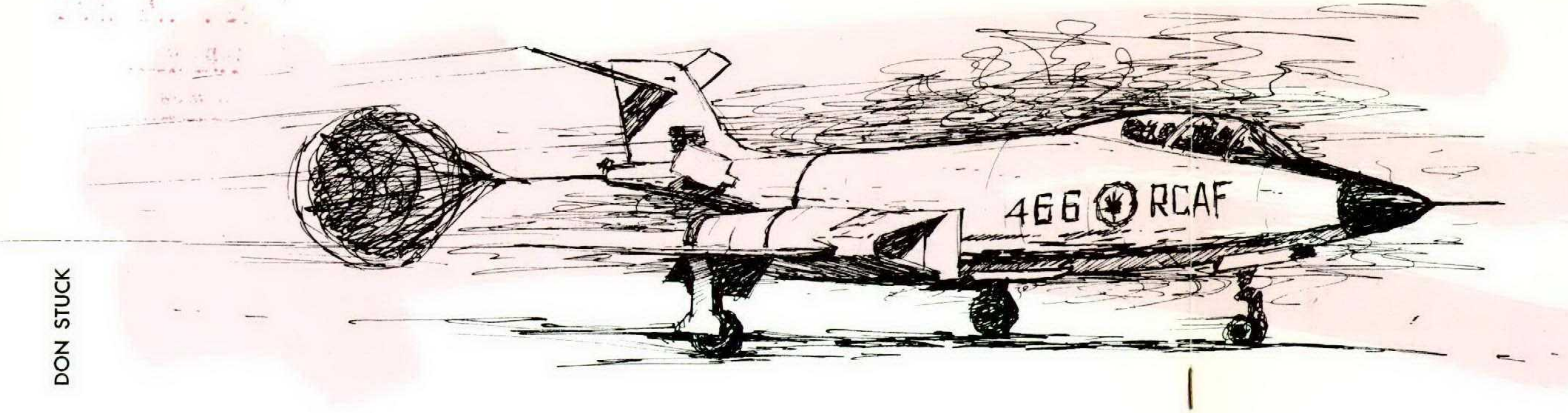
- Moral obligation to those they serve.
- Obligations to fellow workers.
- Rules of conduct.

The common ideals, the common traditions, the common understanding of all airmen make a code of ethics unusually desirable and applicable.

APPROACH

Ethics are instilled by example and by experience

by Jerome Lederer
Managing Director, Flight Safety Foundation



DON STUCK

WHEELS, BRAKES and TIRES

This article was written primarily for F101's and century series fighters, however, the same reasoning and problems apply to practically all types of aircraft in use in the RCAF.

The three items outlined in the title, coupled together into one integrated unit and hung on the ends of the struts, comprise a package which is taken pretty much for granted, takes a phenomenal amount of punishment in the normal course of events, and can be severely mistreated by a pilot unmindful of the abnormal energy inputs he is capable of making from the cockpit.

Up to this time the problem has generally been to teach pilots to treat tires with the respect which is due, which is no small task in itself. We now have come up with a new problem which, although not caused directly by pilot input, can be aggravated by the pilot. The problem is wheel fatigue failure.

Mr. Don Stuck, experimental test pilot, came to McDonnell Aircraft Corporation in April 1957 after fifteen years in the Air Force. A graduate of the USAF Test Pilot School, Don was the WADC Experimental Flight Test Officer on the first of the Voodoo series, the F-101A, and has been flying all Voodoo models ever since.

Since the introduction of the F4H, Don's attention has been directed toward this aircraft which will soon show up in the US Air Force inventory as the F-110.

Don's flying career dates back to 1941 with experience in P-40's, P-51's and P-47's. Jet flying started in 1947 and has since included all jet fighter aircraft in the Air Force inventory through the century series birds.

Combat was seen in WW II in the Pacific flying P-47's and in Korea flying F86-A's.

As of this date there have been several instances of wheel failures on Air Force and Navy fighter aircraft. The failures have usually occurred in the hub and bearing area, so it can be easily seen that after the failure the wheel becomes a fairly inefficient "roller."

All interested parties have their heads together to determine what the exact problem is, and what can be done about it from immediate maintenance type action to complete wheel redesign. Until all of this gets worked out, however, it behooves the pilot to learn what the score is and what he can contribute to help ease the situation.

To understand the problem better, let's start from the beginning:

Wheels are designated by a contractor to meet certain MIL-SPEC conditions. Taking numbers from a recent military research and development report, we find that the average fighter aircraft rolls wheels 30,000 feet per mission. This six-mile approximate total is broken down as follows:

27% taxi out
17% takeoff
25% landing
26% taxi in
5% turns (average 12.7 knots on 73.5 foot radius)

The normal fatigue qual test called out for the wheel is to lab-run it under full gross weight conditions for 1,000 miles. Although a wheel passes the qual test requirements for roll life, the design specs do not require rolling of the wheel under side load or high temperature conditions.

In addition, although the normal fighter wheel is supposed to have a service life of about 1,000 miles and then be discarded, there is apparently at present no firm universal military practice for keeping track of expended service life.

The modern fighter MLG wheel is either forged aluminum or cast magnesium for strength coupled with light weight. Since the wheel incloses the brake assembly, the heat potential is naturally severe, and the properties of aluminum and magnesium under severe and/or extended heating periods can change radically.

For example, a qualified aluminum wheel capable of rolling 1,000 plus miles under full gross weight conditions loses 33% of its allowable design stress and 60% of its potential fatigue life under operating conditions of 400°F. The same wheel heated to 600°F has lost 85% of its allowable operating stress, whereas heating to 300°F only reduces allowable stress by 18%.

Permanent change to the strength factor of the aluminum or magnesium wheel can occur if heating is applied for extended periods of time.

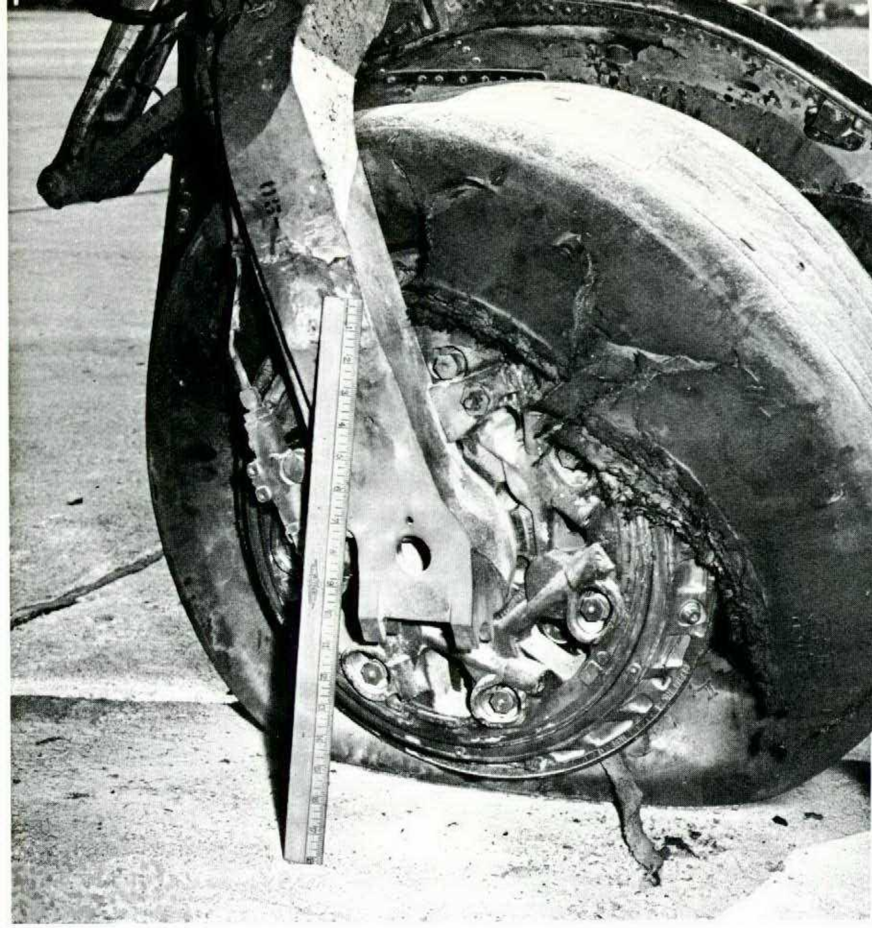
The aluminum wheel heated to 300°, which lost 18% of its allowable stress when operated at that temperature, is back to normal strength when returned to normal temperature. If the wheel is heated to 400°F and held there for 10 hours, it will have permanently lost 20% of its allowable stress when returned to normal temperature. The same wheel heated to 600°F and held at that temperature for only 30 minutes will suffer a permanent 55% loss of allowable stress when returned to normal temperature.

A lab run of a qualified aluminum wheel included holding it at 475°F for seven hours, cooling it to normal temperature, and then putting it on the 1,000-mile treadmill. The wheel went 146 miles before cracks appeared, and failed at 206 miles.

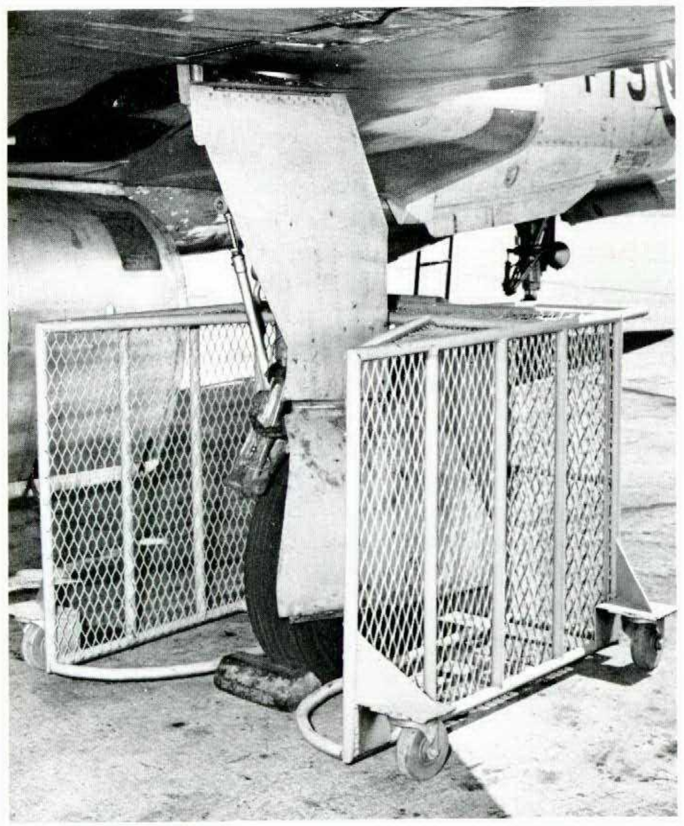
The examples given are for a forged aluminum wheel, but cast magnesium, such as used on the F-101, can start showing the same type strength degradation under heating in excess of about 350°F. Although the temperatures and exposure times in the above lab examples may seem high, keep in mind that temperatures in excess of 500°F have been recorded during extreme test conditions. In addition, it is a known fact that the wheel and tire temperatures after heavy braking reach a maximum between 15 and 30 minutes after the braking application. Therefore, if a fusible plug blows out on the tire or the tire itself blows after an aborted takeoff, it's anyone's guess as to how high the temperature of the wheel has risen.

The high temperature, half hour exposure, permanent degradation of wheel strength now starts to look pretty realistic and leads you to believe that possibly we should consider scrapping wheels which have been heated to the fuse plug actuation or tire blowing point. This is all part of what is being considered; but what can we do right now?

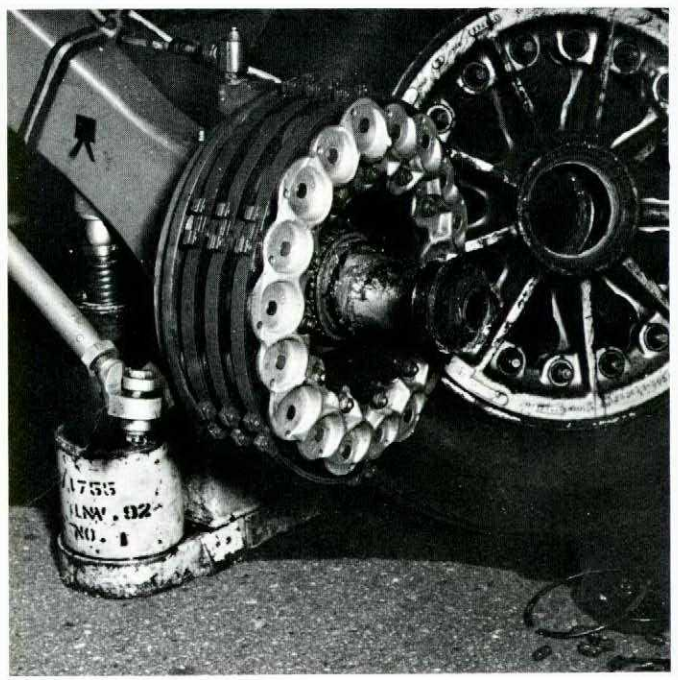
When we talk of heat, we're naturally talking brakes. If you stop to consider the amount of energy that is involved in stopping the mass represented by a modern fighter such as the F-101 or the F4H, and converting it to heat,



- Heat deteriorates all wheel components. Heat control is a large part of the pilot's job.
- Proper touchdown point and right speeds are prerequisite for long tire and brake life.
- Use the drag chute, taxi slowly and make wide turns and the wheel and brake systems will hack it when you really need them.



Safety shields were placed around this Voodoo's wheels after a hot landing.



you can readily imagine that a lot of heat is manufactured by the brake. This spells out a rehash of proper braking techniques.

- Don't fly an aircraft which you suspect has a dragging brake.
- Don't ride the brakes.
- Don't taxi fast; this requires more than normal use of brakes.
- Don't pump the brakes; use steadily increasing pressure to the amount needed, for as long as needed, then get off them.
- Use nose steering for directional control.
- Plan ahead. Make as few stops as possible.

The other factor in premature wheel failure to be considered by the pilot is side load. Obviously, we can't stop making turns in taxiing, but do have control over how we make the turn. Therefore, for the given number of turns required for a given mission, the pilot, and the pilot only, dictates the amount of side load that is applied to the aircraft.

Let's go back to the lab again to determine what happens under given test side load conditions and then see if we can't reduce this force to "pilot in the cockpit" type parameters.

As we pointed out earlier, the military report which laid out the average fighter aircraft mission stated that the "average" turn is 73.5 ft. radius at 12.7 knots. Now, how they arrived at that figure I can't say, but it looks pretty realistic, so let's use it as a base point.

It is centrifugal force which gets into the act to cause our side loads around corners. Taking a given side load, speed, and turning radius, it is interesting to note that, if we double our speed, we must increase the radius by a factor of four to stay at the same side load conditions. Therefore, that little bit of speed increase "around the corner" during taxiing can do astronomical things to side loads applied to the wheels and tires, since, at a given radius, the forces increase as a square of the speed increase. The greater the mass, the greater the problem, which means that taxiing out at the higher gross weights is even more critical than taxiing back.

In F-101, F4H, and other aircraft ground-run programs with which I have been associated, I have always been startled at the amount of error between the pilot estimate of taxi speed and the actual speed of the aircraft. I think it can be safely said that the average pilot taxies aircraft in the F-101 gross weight/size category at roughly twice the speed that he thinks he does.

Getting back to the lab and the 1,000-mile test: a qualified wheel under high takeoff gross weight conditions was placed on the treadmill at the equivalent side load of a 100-foot radius turn at 20 knots. This wheel failed in fatigue after only 21 miles of rolling. This was a severe test and, while it is of course not conclusive, it surely is indicative of what's going on when we try the "hot rod" technique to and from the parking area.

The tire wear and blowout problem shouldn't have to be even mentioned, but let's go through it again anyway.

First and foremost is tire service. Although it isn't expected that pilots should be checking tire pressures before flight, you can check with Maintenance to assure that tires are being pressurized to exact T.O. figures for the gross weights you are flying. I bring this up only because I personally ran into a maintenance outfit which was purposely underinflating the tires in an attempt to prevent "chunk losses" on the wearing surface.

There were only two problems—the cause of "chunk losses" was excessive side loads (high speed cornering) and not overinflation, and the excessive rolling flex caused by the underinflated tire was generating so much heat that tires were blowing with great regularity during the taxiing out to takeoff. Inflating the tires properly and enforcing proper taxi speeds "magically" solved both the blowout and chunk loss problems. A lot of study went into those book figures—don't sell them short.

Now to get to the cockpit inputs—

There are several ways to ruin aircraft tires, which incidentally cost about $100 each. You, the pilot, again directly control the parameters which can cause this ruin:

- Excessive side loads cause abrasive scrubbing and "roll over", which lends itself to losing large chunks if you happen to run over a small sharp stone while under high side load conditions.
- Improper use of brakes can cause permanent cumulative deterioration and possible blowout due to heat.
- Excessive centrifugal speed. If you check the max design rolling (ground) speed your tires are good for, I venture you'll be surprised. For the F-101 it's a speed between 180 and 217 knots, depending on the tire being used. Those hot landings can hurt here too, in addition to having that much more energy to dissipate in stopping.

We've already gone over the use of brakes and nose gear steering in taxiing, so, if we add the proper techniques to avoid excessive side loads on both the wheels and tires, we have it just wound up:

- Cut down taxi speeds, as we pointed out earlier; in particular, slow way down before entering a turn.
- Make turns as wide as practicable.
- Take it especially easy at high gross weights.

When it comes to abnormal punishments for wheels, brakes, and tires, there's nothing like a lousy final approach and landing to really "set the stage."

Take the very familiar 10-30 knots hot on final approach. If you desire to touch down "on speed," you're forced to use a lot of runway to float over to get down to proper touchdown speed. This results in abnormally hard braking to get stopped in the remaining runway, with possible blown tires, and maybe even off the end. The other alternative is to "cram" it on the ground as soon as you get over it. Here you stand a chance of exceeding the design ground speed of the tires, or, at the very least, losing a lot more rubber on touchdown than necessary. Then, after we're on the ground, we've got a "few" extra knots to take care of with the brakes. Remember, energy increases as a square of the speed, so that extra 10 or 20 knots isn't "peanuts."

Basic Rehash

- Proper final approach and touchdown speed.
- Utilize all drag devices possible to the best advantage. Aerodynamic drag, drag chute, flaps, speed brakes—all help you get slowed down to the speed where wheel braking becomes the most effective way to get the aircraft decelerated.
- At proper speed bring the nose gear down and use what braking is needed to get stopped.

It sounds so simple and straightforward that it hardly seems worth mentioning, but study the taxi, takeoff, and landing techniques of other pilots or other squadrons. Are they treating the wheels, brakes, and tires with the respect due them? Now—how about you?

INTERCEPTOR, June 1962

COLD WX NOTES

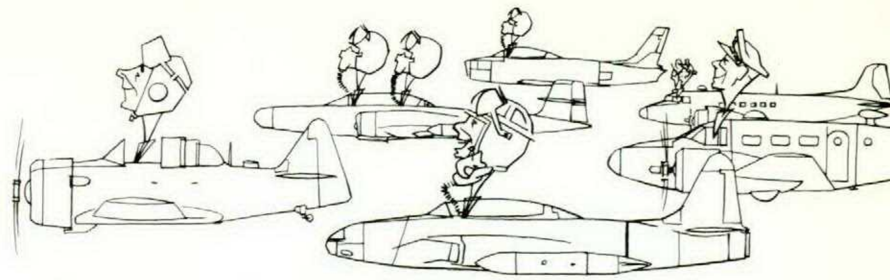
Now is the time to renew familarity with the effects of low temperatures and wintry storms on instruments and power plants, on flight including landing. Doing so really will make a difference when, for many units, November days and nights produce dropping temperatures.

How to prepare for the days to come? Use existing publications on winter flying, cold-weather equipment and gear, snow-removal, protective clothing. Put the pilot and maintenance winter-operations reading files into circulation. Make these topics the subject of lectures and discussions for pilots:

- The need for flight instruments to be thoroughly warmed up before takeoff into sub-zero temperatures.
- The complete anti-icing and de-icing system of aircraft.
- How to detect and combat carburetor icing and jet engine icing.
- Know the icing level.
- What to do when encountering severe icing, freezing rain, and extreme turbulence.
- The value of inflight reports of unusual and unfavorable weather conditions, particularly heavy-icing turbulence.
- Pilot technique when landing and after landing on snow or ice.
- Crosswind landing on icy runways.
- Pilot knowledge of oil-dilution systems and co-operation with maintenance personnel in using them.
- The need to keep physically fit and to understand cold-weather-survival technique.
- Personal equipment and cold-weather survival.

Every commander, inspector, and experienced flyer realizes that winter flying demands extra care. This, and the required precautions, must be instilled in all, but particularly in the less experienced aircrews.

TIG "Briefs"



HEADS-UP FLYING

F/O H. G. LARSEN

F/O P. R. DeLONG

F/O P.R. DeLong was the pilot of a CF101B and F/O H.G. Larsen was the observer. They had completed an AI mission and had entered the control zone to start a practise ILS approach. At this time the pilot noticed his ASI and TAS meter fluctuating wildly and reading abnormally low for the power setting being used. The approach was discontinued and the tower informed of the difficulty. A VFR holding pattern was initiated while the pilot assessed the situation.

By some quick original thinking F/O DeLong decided that an unassisted approach using facilities still available—such as the airborne radar—would be the best procedure to try for an approach and landing. Under the circumstances, with the amount of fuel remaining and the time required for a scramble and join-up, an unfamiliar night formation approach might be too hazardous.

To establish an approximate safe airspeed for lowering the gear and flaps F/O Larsen used the radar to lock-on to a ground position and obtained ground speeds to which he applied the known winds and was able to tell the pilot when the safe lowering speeds had been reached. He used this aid throughout the approach calling out speeds to the pilot. At the start of the descent the pilot set the throttles for 85% and continued in with a normal approach using the same aircraft attitudes as normally required for a GCA. The final approach and touchdown were normal and the landing roll did not exceed the usual 6000 feet.

Here is HEADS-UP FLYING at its best. This crew, familiar with the systems and procedures, reacted quickly and resourcefully to an emergency situation and through excellent crew co-operation brought their aircraft down for a safe night landing.

The cause of the fluctuating ASI was excessive leakage in the pitot line. This was traced to a loose pipe fitting in the pitot drain line between the nosewheel-well blanking cap and the cockpit floor. It was determined that the fitting must have worked loose in flight. Inspection procedures have been changed to prevent future occurrences of this kind.

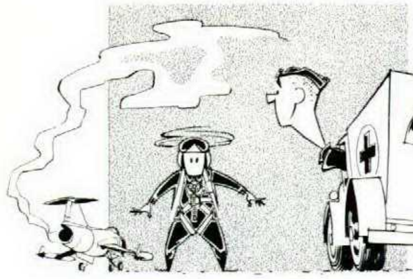
F/O J. A. BRAND

F/O J.A. Brand and a student pilot were on a training flight. After takeoff, post solo 13, and about 15 minutes of stalls and aeros were completed. Three overshoots were made and after a normal PFL, the aircraft was returned to circuit.

Everything in the flight appeared normal until the RPM indicated zero on the down wind leg. F/O Brand realizing something was wrong took over the controls. He moved the pitch control but got no reaction so the lever was left full fine. The MP was left at 25" because the engine seemed to be running at 1750 RPM. Within 20-30 seconds the oil pressure was reading zero. The throttle was retarded and the aircraft was landed. On touchdown the fuel and switches were turned off and the prop stopped abruptly.

It is suspected that there was a failure in the accessory drives which drive the tachometer and oil pumps. This would cause complete loss of oil pressure with subsequent engine failure. It was fortunate in this case that the failure occurred in the circuit. However, it must be noted that only by decisive action and good flying judgement was F/O Brand able to land the aircraft without further damage.

F/O Brand's Heads-Up professional airmanship merits commendation from Flight Comment.



OPERATIONAL HAZARD

COSTLY DISTRACTION

A recent AFS graduate was authorized for practice intercept mission in a T33 as #2 Fighter. A normal mission was carried out followed by touch-and-go landings. After a final touch-and-go landing, as the pilot extended his left arm down to raise the gear, three pens in the left upper arm pocket of his flying suit were caught behind the left canopy lock-linkage guard. He raised the gear and flaps, then diverted his attention to releasing his arm, leaning more and more to the left and jostling his arm and shoulder around. He became so engrossed in releasing his arm, that he allowed the aircraft to settle back on the runway.

He pulled back on the control column and the aircraft became airborne and he climbed away. The aircraft was severely damaged and he had no indication on his airspeed indicator. He called the tower for help and subsequently another T33 formated on the aircraft and helped him to bring in the damaged aircraft for a normal landing.

The airframe of the T33 was considered to be beyond economical repair and the engine was returned to the contractor for overhaul—all this caused by a nod of the head and a tug of the shoulder at a critical moment during the flying of an aircraft.

As a result of this accident a UCR and an Operational Hazard report have been submitted with the following possible solutions:

(1) The leather pencil-holding portion of the pocket be relocated on the inner left forearm position of the flying suit.
(2) A leather flap and clasp be designed to fold down over the tops of pencils projecting from the slots of the upper left arm pocket.
(3) The leather pencil-holding portion of the pocket be removed forcing pilots to carry their pencils in the less convenient slots on the right shin of most flying suits.
(4) A safety notice be promulgated informing pilots of the possible danger and admonishing them to keep pencils in the shin receptacle.

All these suggestions are being studied with a view to eliminating this hazard, but in the meantime pilots flying T33 aircraft should be warned that pens or pencils in left sleeve pocket of flying suits are liable to get caught behind this canopy lock-linkage guard when the pilot reaches for the undercarriage handle. The possibility of losing control when attention is diverted even momentarily is a hazard all pilots must consider and guard against.

DESTINATION FEVER

We RCAF pilots are the carriers of a terrible disease, as deadly and damaging as cancer. Unlike some types of cancer, it can be checked before it's too late. With a bit of determination it can be eliminated as well. The name of the disease is "destination fever", and its chief symptom is a tendency to get home with a minimum of delay.

Sometimes (to the surprise of us all) flyers do reach home with minimum delay—leaving widows and orphans. It's a world of speed today, flyers as well as travellers develop a restlessness that sometimes makes demands beyond capabilities. We want to get back home—and end up in a big crash.

Destination fever is like all other fevers; it raises the body temperature, and, if it remains unchecked, delirium sets in and the mind wanders to a point where the preflight is incomplete and flight planning is inadequate. After takeoff, destination fever really takes hold; the primary cause factor of the potential accident has been initiated.

Most of the time, the desire to get home or to get some other place right away is self-created. There's something important to be gained by reaching our destination, so we take off with a known unserviceability, questionable weather, and without using our best judgment. Statistics show that most of these engagements usually terminate in a flaming heap of aluminum.

The best way to be sure of a cure for destination fever is to ground the pilot—a solution some people have used much to the pilot's dismay. But that isn't the answer. We must educate ourselves, commanding officers, wives, and the people who dictate the administrative procedures connected with flying.

Often a supervisor will release a pilot to fly somewhere with the remark, "As long as you get back for work Monday". Immediately, a goal is established. If the pilot is not instrument-rated, experienced, and current in flying, such a demand to return by target date and time may induce unsafe VFR.

Normal one-day trips are often hampered by weather, late arrivals of passengers, or minor maintenance problems. The plane is due back for a flight tomorrow, the wife wants to go to a bingo, the pilot wants to get home, and Accounts won't pay TD, so the young tiger takes off.

The most important influences on our hero's decision are probably his wife's desires, and her failure to leave him enough change to buy a Coke at the bar. The five famous "Ms" include the causes of destination fever. The physiological and psychological conditions of Man are the main factors. He must be trained to calculate the risk involved, and then make rational decisions. Machines, Mission, and Medium are also important, as is proper Management.

If Man is the main cause factor of destination fever, he must not only be educated out of the habit of hurrying things, but must decide if a slight risk is fully justified. A night away from home, a few extra dollars in his pocket, and a promise to his wife, should not lead him to the point where his life may be lost and expensive machinery wrecked.

Supervisors must learn not to push flights beyond the capabilities of pilots under their supervision. Their physical and psychological capabilities must be kept in mind before duties are assigned; fixed times and dates should be avoided if possible, and weather must be respected.

One night's delay will cost the RCAF some TD, and the pilots and passengers delay—but it may save thousands of dollars, human lives, insurance claims, and dependent benefits. That's a big saving!

If we can educate ourselves, our supervisors and our staffs to consider operational problems rationally, teach our wives how to keep the pilot in a trouble-free frame of mind, and allow some flexibility in TD dates, we can help eliminate destination fever. All it really takes to cure this disease is to do a 180 and land—or stay on the ground.

Adapted from an article in U.S. Army Aviation Digest by Major S. H. Gillani, Pakistan, Army.

ARRIVALS and DEPARTURES

Resumes of accidents are selected for their interest and the lessons which they contain. The time required to complete the accident investigation and the additional time necessary for publication generally totals six months.

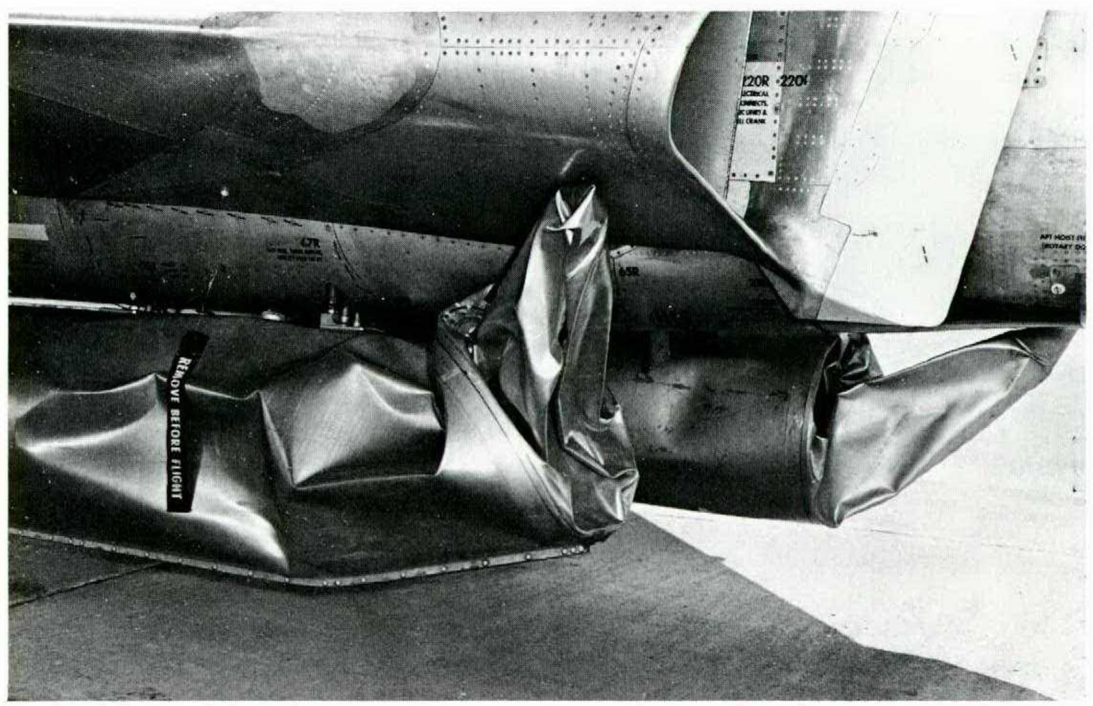
FUEL TANK COLLAPSE

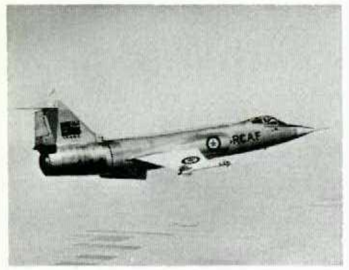
A CF101B on a ferry flight to Bagotville was cleared at an altitude of 38,000 feet. Three minutes prior to ETA, clearance was received and a rapid descent commenced. On passing through 17,000 feet, two loud thumps were felt and heard, one on the port side followed closely by one on the starboard side. Checking the aircraft carefully and requesting tower to do an external visual check it appeared, apart from a slight vibration, that the aircraft was normal and a safe landing was carried out.

After landing it was discovered that the external fuel tanks had collapsed. These tanks had been fitted to the aircraft purely to transport them to Bagotville. The fuel and vent lines had not been connected to the aircraft system and they contained no fuel.

Further investigation revealed that the fuel and air fittings of the tanks were sealed by two layers of masking tape and the fuel fitting had a plastic cap under the tape. During ascent the air pressure in the tanks equalized to ambient pressure through slow leakage through the masking tape but during rapid descent this leakage was insufficient to permit equalization of pressure and the tanks collapsed.

The incident was assessed as "Maintenance" and contributing to incident "Briefing - Lack of Supervision". The tanks were damaged beyond unit repair capability.





"FOD ON FOD"

A recent occurrence which led to damage to two J79 engines on one CF104 in a two-day period, points up the need for increased knowledge, supervision and operating procedures.

A CF104 was being run-up for a suspected afterburner malfunction. After shutdown it was noticed that the flag and pin in the starboard side of the bomb dispenser were missing. Investigation discovered the flag draped over the front engine frame strut with the pin torn off and presumably ingested. Inspection revealed nicks in the compressor blades and the engine was returned to contractor for strip.

The cause of this accident was general maintenance error in that it was not generally known that during flight, the boundary layer duct discharges air, but during ground run, a reverse flow occurs and can draw foreign objects into the engine. Duct plugs were available but an awareness of the need to use them was not.

Unit corrective action included an educational and check-out program, and a directive instructing crew men to remove safety pins and flags before starting engines and taxiing from the line.

A day after this occurrence a new engine was fitted and on run-up, some small explosions and rough running occurred. When the boundary layer duct plug was removed three small screws were found and two more, further in the duct.

Investigation revealed that the crew who had removed the other engine, taped the cover screws to the side so they wouldn't get lost. A total of 10 screws were taped, but only five found. The other five? Well this engine was removed and sent to contractor as well.

Two engines in two days. How is your Foreign Object Damage control? Could this type of thing happen at your unit?

SEEING IS BELIEVING

This happened to the driver of a vehicle on a taxi strip. He wasn't watching where he was going and collided with a CF100 wing tip, as he stated "the area I was occupying from my chest up was replaced by the wing of the aircraft"

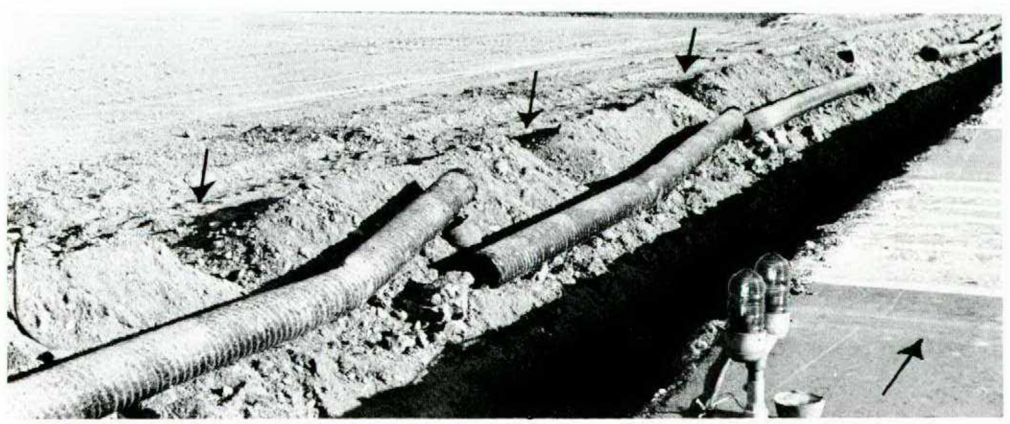
TOO LONG A LANDING

Shortly after a heavy rain the captain of a Neptune approached the airport for a landing. The runway was 5,000 feet, the last 500 feet was reported unserviceable and was to be used for taxiing only.

The aircraft touched down about 1,500 feet from the approach end of the runway and was unable to stop before running off the end and striking the far lip of an unmarked six-foot ditch. It continued a further 700 feet where the nosewheel encountered another unmarked ditch and broke off. The aircraft then stopped with one main wheel in the ditch and the other beyond. Considerable damage was done to the aircraft, but there were no injuries to the crew.

On touchdown the pilot used reverse pitch for a short period, stopped the procedure and commenced braking. When he realized that braking action was poor and appeared to have little effect on the forward motion of the aircraft, reversing was again tried but the levers would not go into reverse. Brakes continued to be ineffective and the aircraft ran off the runway.

The pilot landed long on a wet runway allowing himself approximately 3,000 feet to complete the landing. In addition to inadequate reversing he also failed to compensate for poor braking conditions. The pilot made a wrong decision by attempting to complete the landing rather than go around.



UNHITCHED

A mule, D6 type, was towing a low flat trailer near the flight line. Four men rode as passengers on the mule and one man on the trailer.

As the trailer-mule combination turned a corner the trailer became unhitched, and in spite of the efforts of its passengers to stop it, the trailer carried on and struck a parked Sabre.

The mule had an unauthorized rope release attached to the trailer hitch, and it is thought that one of the men on the mule may have inadvertently released the trailer by grasping the rope during the turn. Special care is required when operating vehicles in the flight line area, and this accident provides further evidence of this basic truth.

"WHOOPS"

A four-plane formation of Sabres had completed an exercise and approached the base for a normal break and stream landing. They broke normally and began their approach. Everything seemed alright, until, at about 50 feet above the ground on final, the number two Sabre appeared to drop out of the sky in an uncontrollable condition, strike the ground short of the runway and slide to a stop. The pilot received minor injuries.

It was later determined that the pilot of number two in the formation had allowed his aircraft to become affected by the jet wash of number one at a critical height where despite his efforts, control could not be regained before contact with the ground was made.

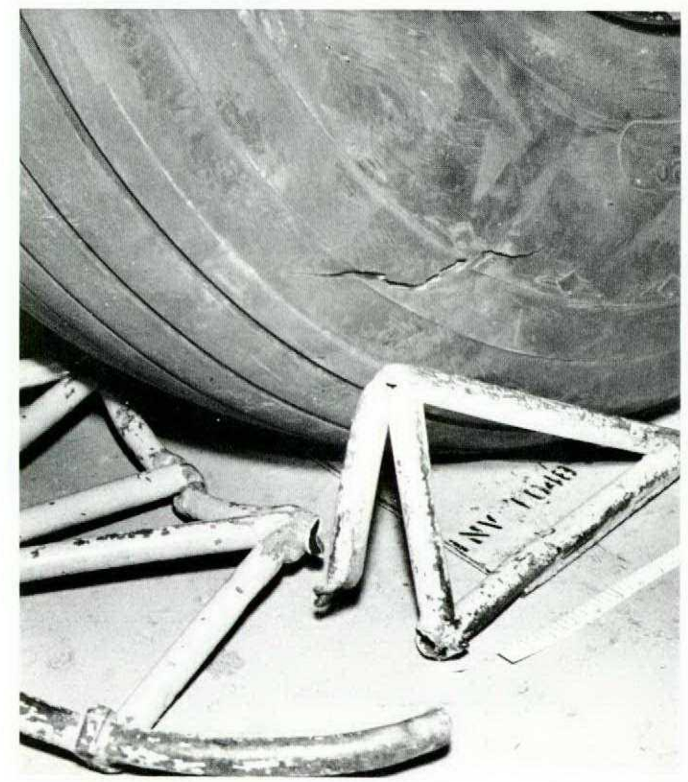
Pilots are reminded of the dangers involved in stream landings. Don't get too close or into the jet wash of preceding aircraft. You may not get away with minor injuries.

A SAD STORY

After landing, the left front wheel of a C130B went flat. On shutdown it was found, that the left and right rear main tires were also deflated, and the right front tire had a hole in the side of the casing. No brakes had been used during the landing roll; the aircraft had been stopped using reverse thrust only.

The Commanding Officer assessed the cause as Groundcrew–carelessness, negligence, and poor supervision. Appropriate action was taken. During run-up of the aircraft, the night before, brakes had been improperly set and it had rolled forward and crushed the wheel chocks, causing internal damage to the tire. Although the tire was inspected, the harm was not discovered until the subsequent failure.

This was the first flat tire experienced by the squadron in sixteen months of operation. It is indeed disappointing to have such a record broken in this manner.



DANGEROUS SLIDE AHEAD

A C119 was being loaded at an Air Movements Unit. The floor was fully loaded on both sides. After the last pallet consisting of about twelve steel plates and six garden rakes had been loaded, the steel plates started to shift to the left. The two bottom pallets were of different heights so that the load was on a bit of a slant.

Fearing the metal sheets might continue to shift and go through the fuselage, the forklift operator tried to remove them. In the process, and as he started to proceed backwards, the movements of the forklift started the metal plates sliding. Before clearing the aircraft, about nine of the steel plates, weighing about 700 pounds slipped from under the metal band tie-down. They struck the port clam shell door inflicting damage to the door and fuselage.

The aircraft was unloaded and returned to the station with doors removed and carried in the cargo compartment. A new clam shell door was required and the fuselage was repaired at the unit.

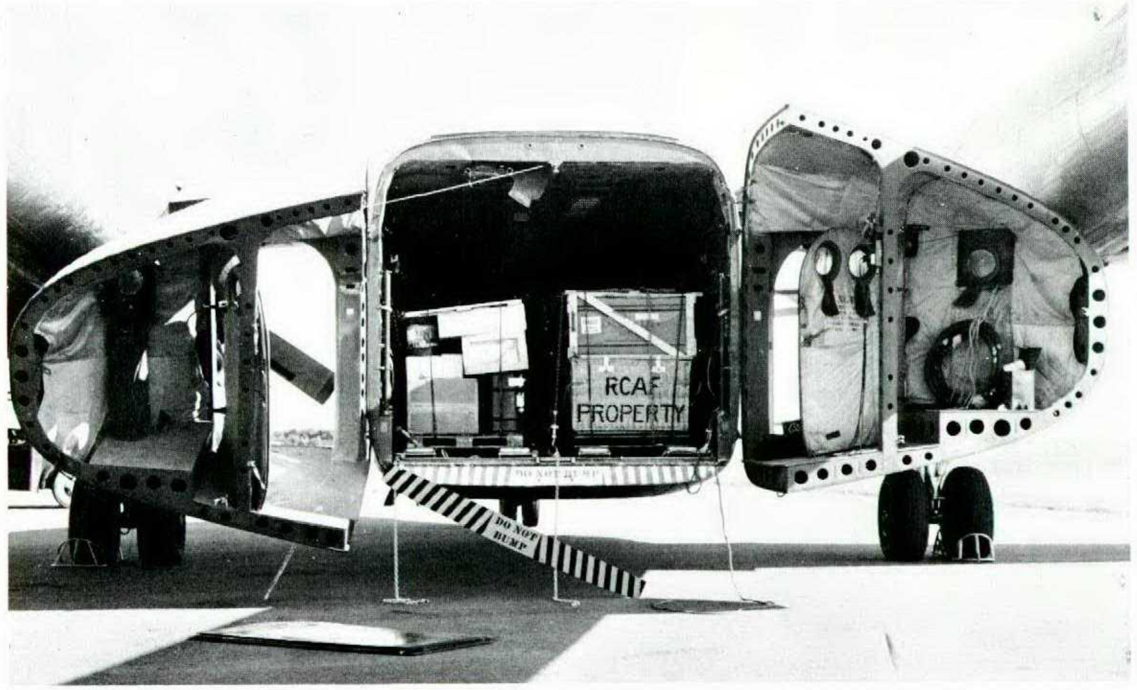
The cause of the accident was assessed as ground personnel - error in judgement. The primary cause of this was insufficient and improper pallet strapping commensurate with a shipment of this type. The pallet was strapped by three pieces of metal strapping from side to side but not from end to end.

A secondary cause of the accident was error in judgement by the aircraft loading supervisor. An attendant fact to be emphasized here is "Haste Makes Waste". Let the urge to expedite cargo handling be subordinate to the valuable time required to evaluate a safety hazard. This was the first occasion that this staff had encountered a load of sheet metal plates for airlift and did not recognize the potential dangers involved.

EASY DOES IT

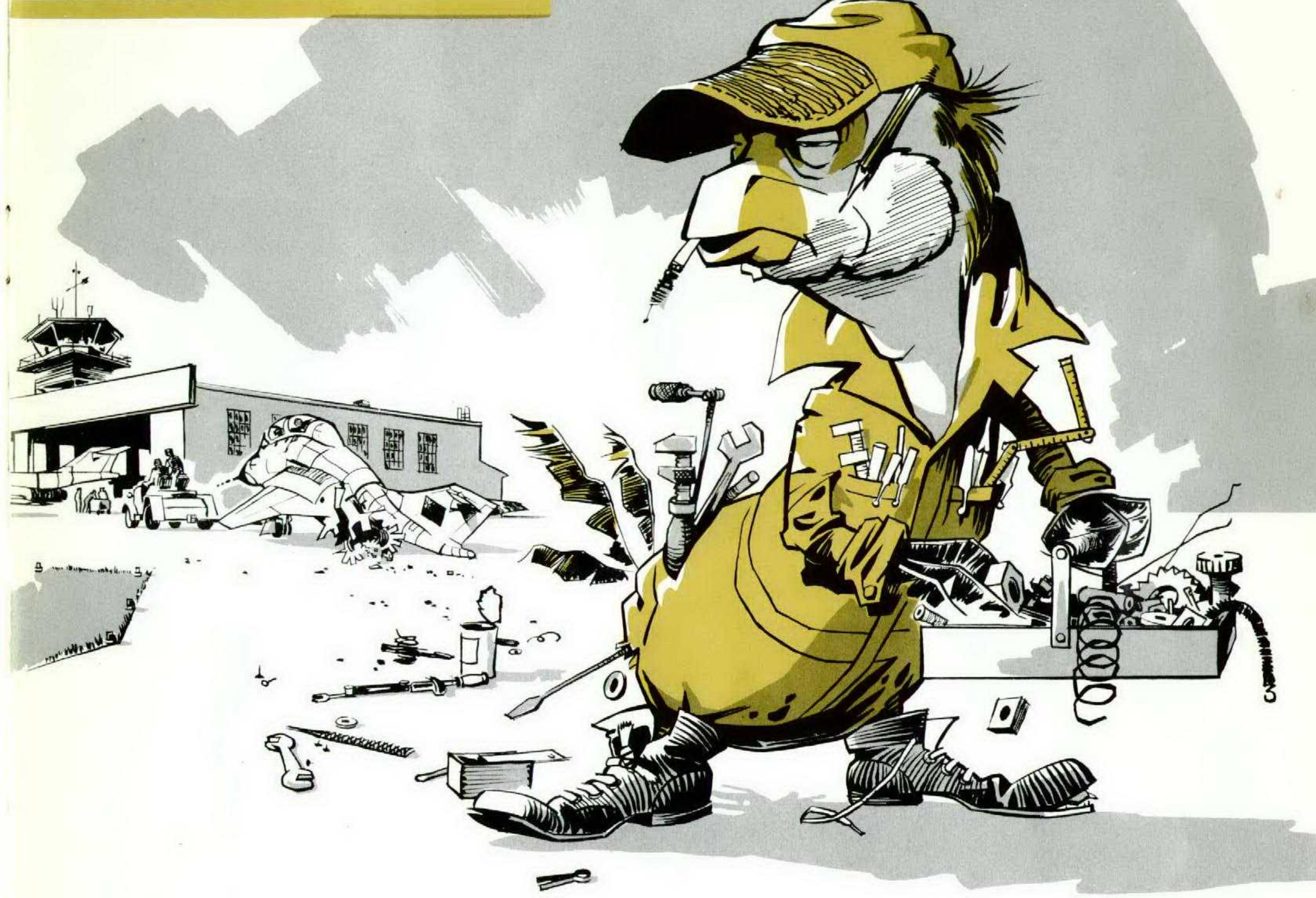
An airman driving a forklift, backed away from a C119 and struck the lower port fin. The weather was good and there was no apparent excuse for such an accident. Disciplinary action was taken against him.

Flight Comment reminds all personnel, that rarely is there any excuse for a ground accident. Personnel must be constantly on their toes when working around or in the vicinity of any aircraft.



Contributed by: S/L J. E. A. Hermanson
AFHQ/CAS/DFS

BIRD WATCHER'S CORNER



LACKADAISICAL FOD SPREADER

A close relative of the MIGRATING NEST FOULER but much more dangerous. In addition the smaller birds can create as large a hazard as the larger, all of which nest in areas adjacent to jet aircraft bases.

This species roams aimlessly about parking and taxi areas, spreading nuts, bolts, tools and other portable objects which will readily enter air intakes of jet engines resulting in various degrees of damage. The FOD spreader takes pride in its work and is especially efficient in spreading foreign objects in a newly swept area.

A careful watch must be kept for this species and if any are discovered, should be captured (alive if possible) and transported to a non-flying Arctic base.

Call: LOSTMEWRENCH, LOSTMEPLIERS, LOSTMEBOLT, LOSTMEHEAD!

GROUND-AIR EMERGENCY CODE

I	Require Doctor, Serious Injuries.	▷	Will Attempt Take-Off.
II	Require Medical Supplies.	L⌐	Aircraft Seriously Damaged.
X	Unable To Proceed.	Δ	Probably Safe To Land Here.
F	Require Food And Water.	L	Require Fuel And Oil.
≪	Require Firearms And Ammunition.	LL	All Well.
□	Require Maps And Compass.	N	No.
— —	Require Signal Lamp, With Batteries, And Radio.	Y	Yes.
K	Indicate Direction To Proceed.	JL	Not Understood.
→	Am Proceeding In That Direction.	W	Require Engineer.

*A space of 10 feet between elements wherever possible.

DRESS FOR SURVIVAL