FLIGHT COMMENT

MARCH • APRIL 1973

Comments

A recent T33 armament door incident brought to light the fact that most squadron pilots were unaware of a new mod (dated 6 months previous) incorporating a switch on each armament door that prevents the canopy from being moved electrically from the *partially-closed* to the *full-closed* position when either armament door is not properly latched. It was mentioned briefly in the EO, but no special information flash briefing pilots on the operation and purpose of the new MOD was received at the Base. Which brings us to the point that procedures used to get vital information to the troops must be reviewed from time to time to ensure that they are effective–*at all levels.*

* * *

The tendency towards automatic reactions as one gains increasing experience on type is a fairly common occurrence. One of the early symptoms is to find oneself reciting checks without actually looking at (or seeing) the item being checked. A highly qualified instructor was caught out not long ago as he demonstrated an MOT Square to his student. Because the student had just demonstrated how not to do one, the instructor was making doubly sure that he described all aspects of the pattern in detail. In fact he became so engrossed in the exercise that he forgot to reduce power until just prior to the pre-landing check, at which point he rattled off the check (including the airspeed) and lowered the gear – 45 *knots above the maximum speed*, as he sheepishly reported later.

* * *

A recent successful intercept of an aircraft with complete electrical failure, might have had a somewhat less successful ending had not VFR conditions been encountered, because of misinterpretation of emergency hand signals. In-Flight visual signals are illustrated on the centre spread of the Jan-Feb issue of *Flight Comment.*

Front Cover A CF101 of 425 Sqn, Bagotville, launching an ATR 2A during the 1972 William Tell competition at Tyndall AFB, Florida.

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Education and analysis

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Investigation and prevention

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Flight Safety versus Austerity

When resources are shrinking while commitments remain relatively the same, pressures to economize can result in compromise in some areas that are essential to a healthy flight safety condition. The relationship of a tight budget and flight safety may be a sensitive, even an emotional issue, but it is one that is of concern to everyone associated with air operations.

Some of the more obvious factors which can have a significant impact on the operation are organizational changes, establishment adjustments, streamlined training and economy measures relating to equipment inspection, modification and overhaul. Careful examination of these and other factors in relation to a specific operation should permit an assessment of the overall implications both short and long term. Then, provided everyone is aware of their significance, the effects can be controlled by taking special precautions to maintain accepted standards. I am not suggesting that this is an easy process but it is an essential one if everyone involved is to do his part to increase efficiency and productivity in order to meet the goals.

While the factors mentioned above may be obvious, the effects of austerity measures on individual and collective attitudes may be much more difficult to identify and alleviate. Human reactions could vary from minor frustration to a degradation of dedication and integrity. These changes can be so insidious that no one realizes that a serious decrease in safety awareness has taken place until something catastrophic happens. Therefore, everyone from senior management to the line supervisor must consciously anticipate such reactions and counter them by telling people the facts that concern them and what is expected of them.

Knowledge coupled with constant vigilance is the only positive way to ensure that our aircraft accident prevention program is not compromised by austerity.

COL R. D. SCHULTZ
DIRECTOR OF FLIGHT SAFETY

THREAT (HAZARD)

Fire
Noise
Bump/Buffet
Crash/Impact
Penetration
Blast
Flash
Helmet Loss

ENVIRONMENT

Hot
Cold
Humid
Dry
Noise
Vibration
High G Loads
Altitude
Communications
Visual
Night/Day/IFR

BIOMEDICAL

Human Tolerance
& Damage Risk to:
  Impact
  Noise
  Weight
  Center of Mass
  Light
  Temperature Extremes

HUMAN FACTORS

Comfort
Simplicity of Use
Acceptability
Compatibility
Retention
Field of Vision
Fine Head Movements

COMMAND/MANAGEMENT

Appearance
Cost
Standardization
Maintenance Logistics
Availability

USER TASK

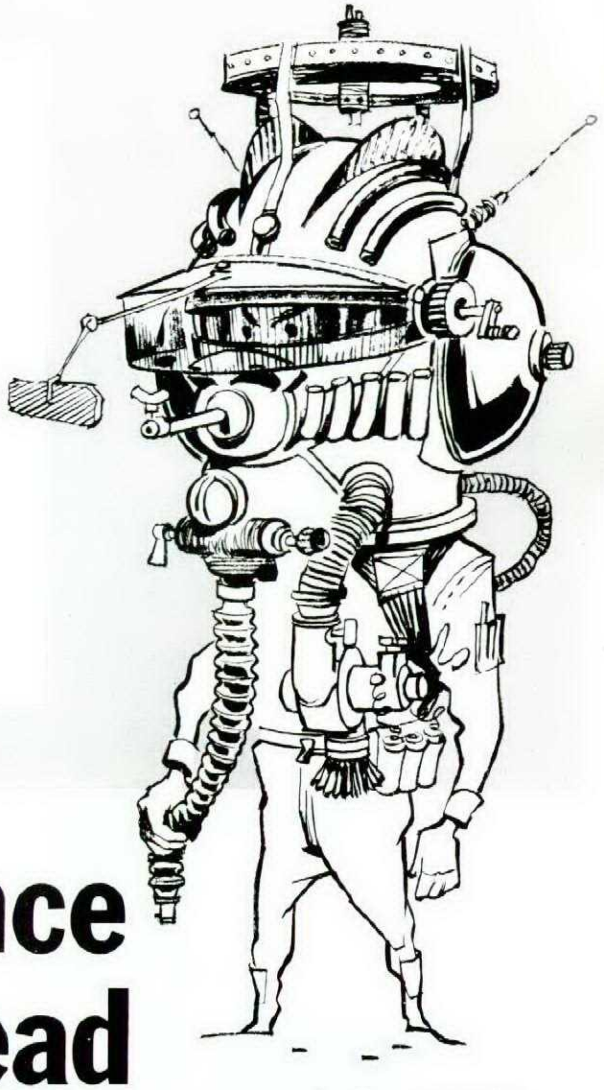
Low and Slow
Low and Fast
High and Fast
Rotorcraft
Fixed Wing
Reconnaissance,
  High/low/water
Weapons Platform
Transport

PERFORMANCE

Durability
Maintainability
Service Life
Reliability
Component Aging

FIGURE 1

MAJOR FACTORS THAT MUST BE IDENTIFIED, QUANTIFIED, ANALYZED AND SUBJECTED TO PRIORITY RANKING BEFORE DESIGN CAN BEGIN



The Art and Science of Saving Your Head

by Capt R.E. Noble
DCIEM

> **And Saul clothed David with his garments, and put a helmet of brass upon his head, and armed him with a coat of mail ...And David said to Saul I cannot go thus, for I am not used to it. And laid them off.**
> **1 Kings 17:38:40**

David knew that when the weight of the brass helmet forced him to his knees his fighting ability was compromised. His observations are as current now as they were then. For years problems of head protection have been limitless, and for those involved with the requirements and designs of aircrew helmets in particular, endless. You may rush off to design your brass helmet but before you do, consider the requirements you must meet (FIG.I). While you are trying to establish the order of priority for the design factors, examine the tolerance and impact levels that the approximately ten pounds of bone and brains on the top of your neck can tolerate.

The data pertaining to tolerance levels, impacts, and types of injuries to the head are mind-boggling. However, most authors point to the difficulty of defining a criterion of safety for the head. Brain concussion may be sustained without skull fracture, yet a blow which causes a skull fracture may cause no damage to the brain.

In addition there are large variations in skull strength from person to person. For a massive impact, however, most studies are concerned with the forces required to fracture the human skull. Estimates of the limit of voluntary tolerance range from 40 G up to 500-600 G. Basically though, the human skull will probably be fractured if one of the following conditions is met:

a. a five foot fall onto concrete at 18 ft/sec or 12 mph;
b. an average deceleration of 200-300 G;
c. a peak deceleration of 500-700 G (equivalent to a peak force of 5000-7000 lbs. for a 10 lb head);
d. kinetic energy of impact of 500-700 inch-lbs; and
e. rate of rise of acceleration of roughly 200,000 G per second.

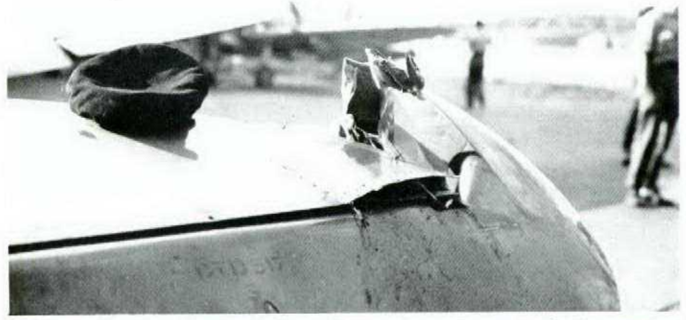
To put the above in context, if an aircraft travelling at 150 ft per second (approximately 102 mph) crashed into a solid object and the nose structure collapsed evenly, with 10 ft. uniform failure of metal, the pilot would be subjected to 30 G. If the pilot's head is unsupported, as the aircraft decelerates very rapidly, the velocity of his head will surpass that of the aircraft by perhaps 64 ft. per sec. If it then strikes a rigid object it will decelerate over a distance of the thickness of the scalp (approximately 1/4 inch) before the skull achieves uniform velocity with the object struck. Thus the deceleration of the skull will be roughly 3000 G. If the object struck – eg, the instrument panel – deforms for 1 inch, the acceleration is quartered to 750 G. If however, a crash helmet can be provided which will allow uniform deceleration over 1/2 inch, this figure is reduced to 500 G – and may be survivable.

It is a sobering fact that attainment of each of the ideal characteristics listed in FIGURE 1 in a single unit is really out of the question because the satisfaction of one requirement usually makes it more difficult to satisfy the others. It is reasonable to expect that the greater the extent and number of useful devices incorporated into the helmet assembly, the larger, heavier and more cumbersome the unit will be. The designers have to accept judicious compromises for each of the desired characteristics so that the product will at least partially satisfy all requirements.

The helmet designer (and you) must keep in mind that the basic requirement for the helmet is to protect the head. The strongest area of the human skull is the intraparietal or crown region. The frontal area is twice as strong as the occipital (back). However the temporal regions, notwithstanding the protection afforded by the temporalis muscles, are the weakest areas. The head should be protected from just above the eyebrows (frontal), the crown, the occipital (back) immediately below the base of the skull and the temple regions. If the helmet is worn in such a way that it does not provide the protection, the helmet is either too small for you or it is not being worn properly. Attachments such as visors, oxygen masks, (which do provide a degree of facial protection) and communications, while necessary, also compound the problem for helmet design and head protection. Finally, one of the biggest problems in helmet design is the subjective and contentious issue of comfort. If uncomfortable, the best protective helmet in existence will be unacceptable.

The protective requirements of an ideal aircrew helmet can be summarized as follows:

a. Protection against penetration and abrasion.
b. Protection against skull deformation.
c. Reduction of rotational acceleration.
d. Reduction of peak and mean linear deceleration.
e. Absorption of kinetic energy.
f. Distribution of impact.



"Protection against skull deformation is one of the major requirements for the ideal aircrew helmet."

In addition the helmet must be comfortable, as light as possible, attach securely to the head, should not restrict the range of vision and should provide excellent sound attenuation. The helmet should also be tough, fairly rigid, have a clean surface to minimize drag, be free from projections to minimize torque, and have a low coefficient of friction to facilitate sliding over the opposed surface. It should spread the blow as widely as possible over the head and should not impair the performance of the user.

Some of the above properties are mutually incompatible. In practice, therefore, the helmet can never be ideal. However, by regarding the helmet as being composed of two parts, an outer shell and an inner liner, something approaching the ideal helmet can possibly be obtained.

The functions of the outer shell are two-fold. First it must resist penetration by sharp objects and second, it must distribute the impact forces to the inner lining. Therefore it must be relatively incompressible and capable of withstanding multiple impacts.

The shell may be lined with a harness (suspension type) or with padding (contact type) or with some combination of the two. For convenience they are considered separately.

Suspension harnesses are easy to manufacture. They are cool and their adjustability simplifies sizing. The greatest value of a suspension helmet is that the force from a local blow on the outer shell can be distributed all over the head. If a harness is used, great attention must be paid to the stitching and the attachment to the shell. The harness must not fail under a survivable impact, and it should stretch and prevent the outer shell from making contact with the head. The harness suspension because of its wide range of adjustments is able to cover a maximum number of head sizes with a minimum number of shell sizes. The harness also permits good ventilation. The chief drawback of a suspension helmet is that it has a limited capacity to absorb energy.

Padding materials in contact with the head are the most suitable for energy absorption. The padding is normally used to line the outer shell. The helmet and padding are therefore a unit in contact with the head. A major problem with contact type helmets is sizing, as the inner liner dimensions of the helmet are fixed. This can be overcome by the use of flexible foam pads glued inside the helmet to ensure even contact with the user's head. However, the helmet will then only fit one person and it usually requires expert fitting. Contact helmets are also commonly unstable and have a distinct tendency to shift position or even come off the head during accidents. Because of the compressibility of the lining materials, on impact the fit tends to change and the head may move inside the helmet. Contact helmets tend to be uncomfortable because there is very little airspace between the helmet liner and the head for ventilation and cooling. Finally, the distribution of impact energy is directly through the helmet and padding, giving rise to a localized blow.

The combination or composite helmet is probably the best all round compromise when all factors are considered. This type of helmet has a rigid outer shell lined with a highly efficient padding material. Inside, a light-weight harness keeps the head just clear of the padding material to allow for ventilation and sizing. The webbing harness spreads impact loads in conjunction with the shell and eventually the head would bottom on the efficient padding material to absorb energy. Imagine sitting in a car that is going to crash into a brick wall. A wire fence and a few bales of hay in your path will certainly slow you down before you hit the wall.

The design of the present aircrew suspension helmet was reached after careful consideration of all the known data both published and unpublished. There was at that time of development (early 1960s) certain views expressed by aircrew that the U.S. Navy APH5 contact type helmet should have been bought. However, this was out of the question because there were at least twenty known deficiencies with the APH5.

Briefly the requirement as stated for DH41-2 suspension helmet (the current CF jet helmet) was that it:

a. be comfortable for periods of wear up to three hours;
b. be easy to don (i.e. preferably one piece);
c. be lightweight;
d. provide a high degree of impact and penetration resistance;
e. have a low drag profile and withstand windblast on ejection at speeds up to MACH 1.0;
f. be retained through 50 G deceleration on crash landing;
g. be stable under +10 G and -4 G forces during aircraft manoeuvres;
h. not exceed the head contours by more than one inch;
j. utilize existing oxygen equipment and telecon equipment;
k. have a reasonable sizing tariff;
l. have unrestricted vision; and
m. be comfortable in summer.

To keep the weight low and to provide as little drag resistance as possible the DH41-2 shell is cutaway over the ears. *The protection is maintained by the hard earcups.* This concept resulted from a study of protective helmets recovered from accidents which indicated that the ear area had a low probability of impact and sustained little significant helmet damage. It was concluded that the impact and penetration resistance afforded in this region could be attained by the hard earcups incorporated into the inner helmet without loss of protection. This represents the major design difference of the DH41-2 helmet from other helmets.

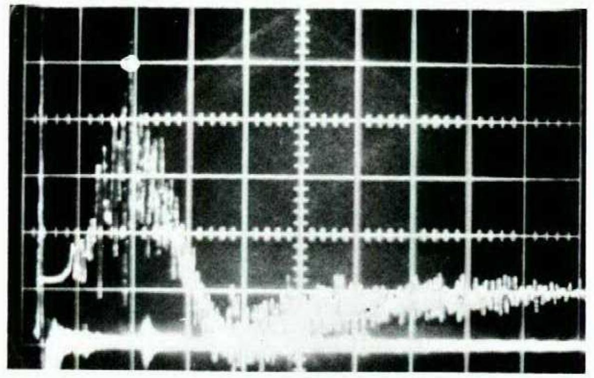
The cutaway design also allows a hinged action between the inner and the outer shell. This enables the helmet assembly to be opened up for easy donning yet permits the inner helmet to be drawn around the face and ears which improves fit, stability, sound attenuation and minimizes aerodynamic drag.

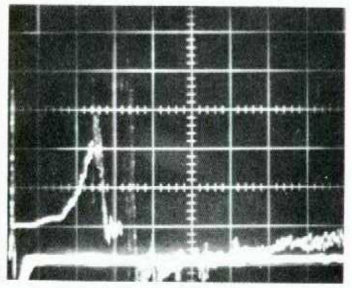
The cutaway feature has been a subject of criticism by many aircrew, therefore before your hair rises a few inches higher, a brief and final explanation follows.

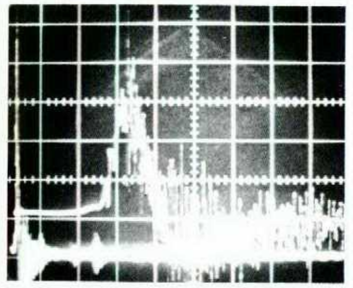
The materials for the DH41-2 shell are the same as the materials for the U.S. APH series Contact Helmet. The test procedures are detailed in specification MIL-H-22995A (AS) 25 April 1969. These require impact testing (16.3 lbs weight, drop height 6 feet 1 1/2 inches represents on impact energy of 100 foot pounds) of the shell assemblies at the forehead, both temples and the occipital (back) regions. Any acceleration force in excess of 400 G or evidence of bottoming is cause for rejection. Bottoming may be defined as very sudden arrest of the head, as when the skull makes contact with helmet shell.

The DH41-2 meets the above tests. However, in the specification there is no requirement to impact the ear area of the shell. There are many reasons why the ear area impact is not specified. The ear area shell would have to be extended outwards which increases both the weight and bulk of the helmet. In increasing the overall size of the helmet, the retention qualities during ejection/windblast would be compromised. A large flexible earcup combined with a large foam filled earseal inside the ear shell would increase the protection but at the sacrifice of sound attenuation. Finally, the small percentage of ear area impact and almost negligible occurence of ear injury, helmet designers are convinced that except for physiological benefits, little can be done to improve the protection around the ears without failing to meet higher priority requirements. Still not convinced? Read on.

A limited test program was recently conducted on three different models of aircrew helmets to ascertain the helmets protective qualities around the ears. The criteria for impact was 400 G as noted in the specification. Illustrated below are three sample oscillograms which indicate there is negligible difference among the three helmets tested. One of the helmets was the DH41-2; the other two were popular aircrew helmets with "ear shells". All three indicate an acceleration in excess of 400 G. It should be observed there is no advantage of the shell extension over the ears.







The problems associated with helmet design and head protection continue to be challenging. Hopefully some will be overcome by new stronger and lighter materials which are under development. If they can be manufactured cheaply and moulded consistently, a breakthrough in helmet design and head protection is possible.

David had problems with his helmet and was not satisfied. Aircrew from other countries are not satisfied with their helmets. Our aircrews are not satisfied with their helmets. The present aircrew helmet is by no means perfect; improvements will be incorporated when they are proven safe and satisfactory. In the interim the helmet you have is a good one, as good as can be designed and obtained within the current state-of-the-art. Treat it with care and wear it properly. When the crunch comes it will perform admirably and that's what counts!

The author joined the RCN in 1949. During the following 14 years, working in the Safety Systems trade, he served on two aircraft carriers, several squadrons and spent four years in CFHQ. In 1964 he was commissioned and posted to CFB Shearwater where he worked for three years as Base Safety Systems Officer. Posted to the Defence and Civil Institute of Environmental Medicine (DCIEM) in 1968, he has since been involved in numerous projects, one of which is the research and development of all types of helmets for the Canadian Forces.

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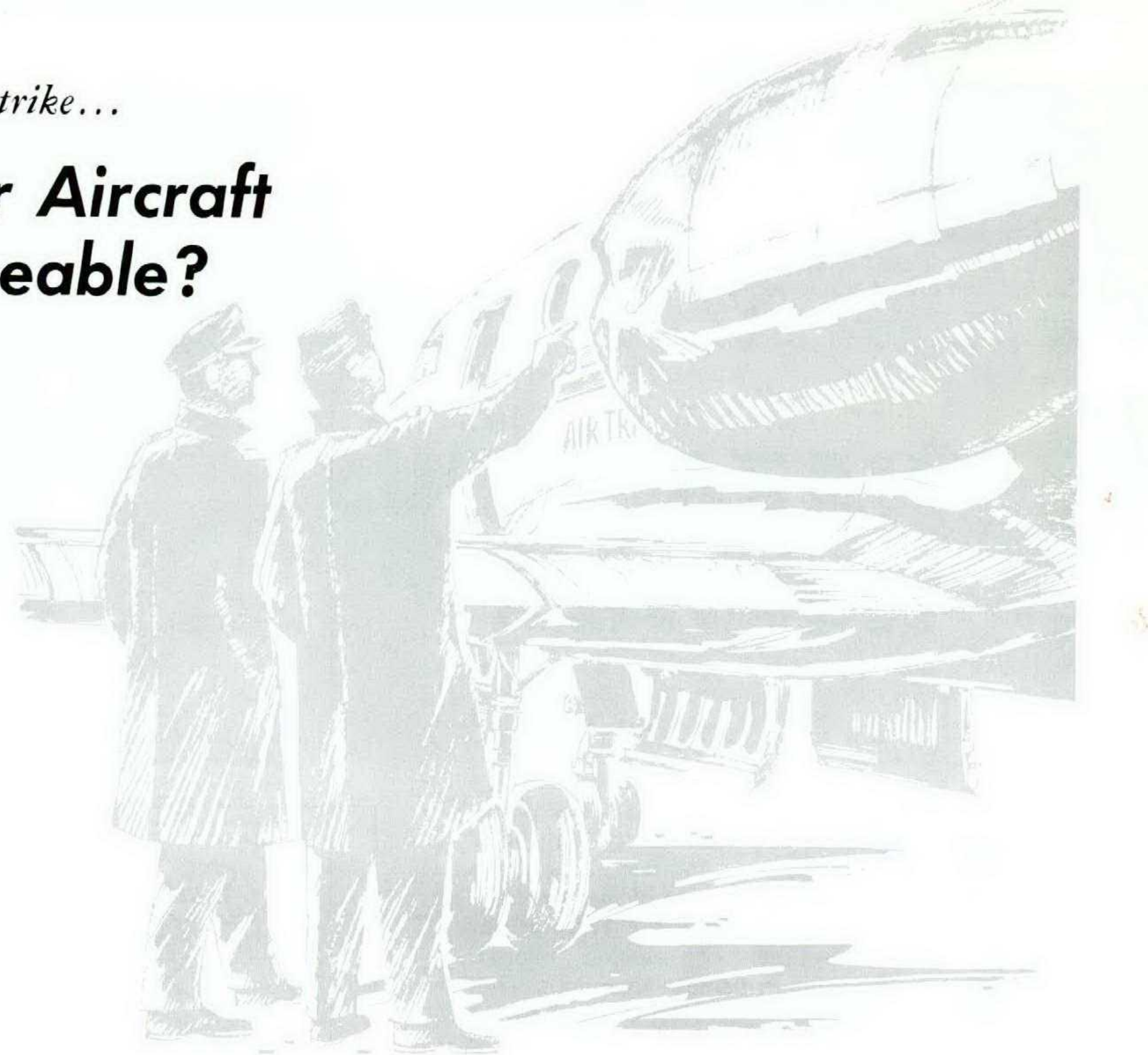
after the birdstrike...

Is Your Aircraft Serviceable?



A Falcon was descending on a night approach into Fredericton when a flock of large birds, probably geese, flashed into view before the landing lights. As the aircraft flew through them there were at least two strikes. The crew were unable to see what parts of the aircraft had been hit, however the instruments gave no indication of any malfunction and a short time later the aircraft landed with the pilots carefully monitoring all engine readings.

Once on the ground the crew carefully examined their aircraft for evidence of damage. One bird had struck the left wing leading edge and the second had hit one of the engine cowlings, with the bird remains passing into the engine. Fortunately the left wing leading edge was not damaged. The engine cowling was dented but there was no other visible damage.

Because they were away from home base, the crew were faced with the problem of ensuring that there was no engine damage. Their inspection was meticulous. After opening the cowlings the crewman completed his initial examination of all parts of the engine that could have been affected by the impact of the bird. Next, the crew telephoned home base and conducted a further inspection under the verbal guidance of an experienced engine technician. Finally, the engine was buttoned up and thoroughly ground run to prove that all components functioned normally.

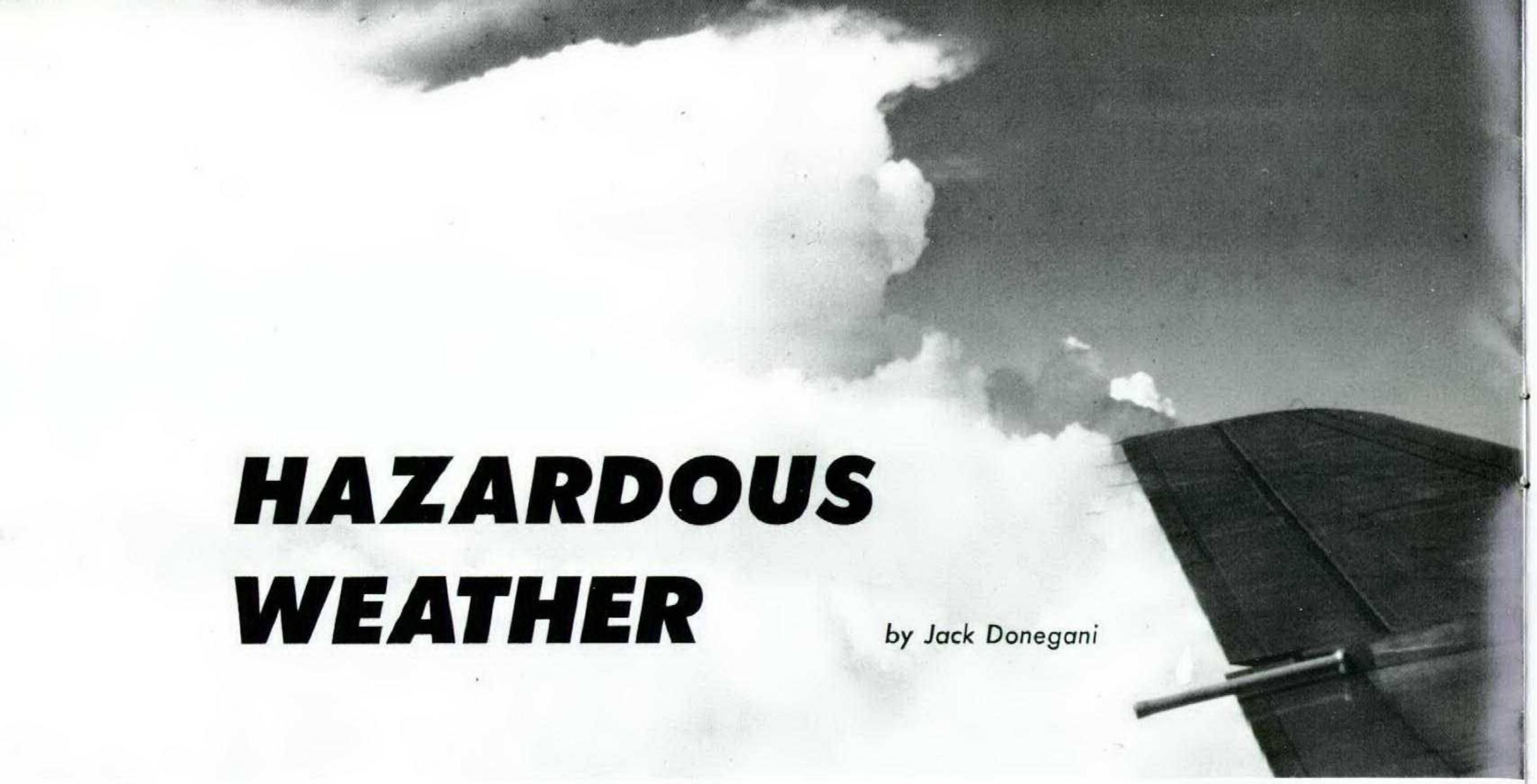
The subsequent itinerary required the crew to fly from the East Coast to Toronto, overflying home base at Ottawa. To be doubly certain that the engine had not sustained damage and to have the cowling repair begun the aircraft commander elected to land at Ottawa and change aircraft before proceeding further.

The actions of this crew demonstrated a professional and systematic approach to making certain that there was no hidden damage to the engine. The tale related here describes one way of taking sensible precautions, simple on the surface, but precautions not evident in the actions of every crew after their aircraft has collided with a bird.

Have you considered what you would do under similar circumstances?

A Strange One

An aircraft (in another service) was in the hangar undergoing maintenance. A transient pilot, unfamiliar with local taxi procedures came taxiing his kerosene burner undirected through an unmarked area. As he turned to park, his exhaust entered the hangar and set off the sprinkler system. The disassembled aircraft was drenched.



HAZARDOUS WEATHER

by Jack Donegani

Safety is everyone's business. From the meteorological point of view safety in flight is enhanced though improved aircrew understanding of the vagaries of weather and weather avoidance techniques. This article examines a number of weather related incidents, resulting in damage to aircraft. The author is a meteorologist at CFB Greenwood.

THE RECORD

From September 15, 1970, until June 16, 1972 there were thirty-seven reports of lightning strikes, static discharge, and/or hail. The breakdown was as follows:

Lightning Argus (2), 707 (1), Buffalo (1), Cosmopolitan (1) Dakota (1), Falcon (1), Hercules (1), CF104 (7), Voodoo (2), Yukon (1).

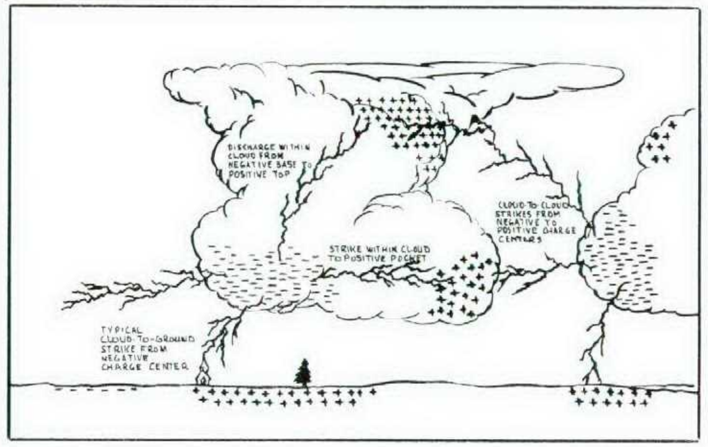
Static Discharge Argus (5), Buffalo (1).

Hail Argus (2), Hercules (1), CF5 (3 incidents to four aircraft in formation, and one incident to a loner), Voodoo (2).

LIGHTNING

The large number of jet aircraft struck by lightning stems from the fact that they move at relatively high speed. An aircraft becomes charged by friction as it passes through a charged portion of the atmosphere; greater speed not only enhances this effect but also tends to move the aircraft from one area of potential to an area of an entirely different potential in a short period of time. Thus, as it approaches another charge centre, the mechanism is available for this charge carrier to attract lightning to itself (or even to discharge itself to the cloud centre).

Since aircraft are better conductors than the surrounding air, they effectively shorten the distance or decrease the resistance between cloud centres. Therefore, the mere presence of an aircraft between two points of potential difference can trigger a discharge.



Electrical Charge Distribution in Thunderstorms, Including Various Lightning Discharges: Intra-Cloud, Cloud-to-Cloud, Cloud-to-Ground, and Cloud-to-Space.

STATIC DISCHARGE

Past evidence indicates that one ideal circumstance likely to bring on this phenomenon is the presence of large wet snowflurries in cumulus cloud. This was the reported weather for 20 December 1971 when a discharge damaged the bomb aimer's enclosure and the fuselage of an Argus. The heavy wet snowflakes can strip off charges as they traverse through the cloud. Positive charges will be dragged downwards, thus setting up the prerequisite potential difference to initiate either a lightning strike or a discharge from the aircraft. National Research Council studies have shown that when an aircraft is flying in weather that has ice particles or snow present, it is likely flying through air that is under this type of electrostatic stress.

It has also been noted that the phenomenon occurs most frequently when the temperature is in the range 0 to -2°C, with light turbulence and little icing. A cruise speed of 160-180 knots at 6000 to 8000 feet can be included among the predominant flight parameters prevalent during Argus incidents associated with discharge.

Of more significance to pilots is that there are forewarnings of this phenomenon. Pilots who have encountered it report that prior to discharge the ADF noise level builds up while the usually quiet VHF becomes noisy. A light St. Elmo's fire effect then appears on the propellers and windscreen, with an inverse cone forming on the nose. Shortly after the inverse cone forms, the discharge occurs.

The fact that the Argus is cited in five out of six incidents of static discharge can be related to the operational tasks assigned to Argus Maritime Patrol units, as well as to the size of the propellers and fuselage. Larger aircraft are more susceptible to such hazards due to the greater stress applied on the electric field between two charge centres. Hence a larger plane may trigger a strike where a smaller plane will not.

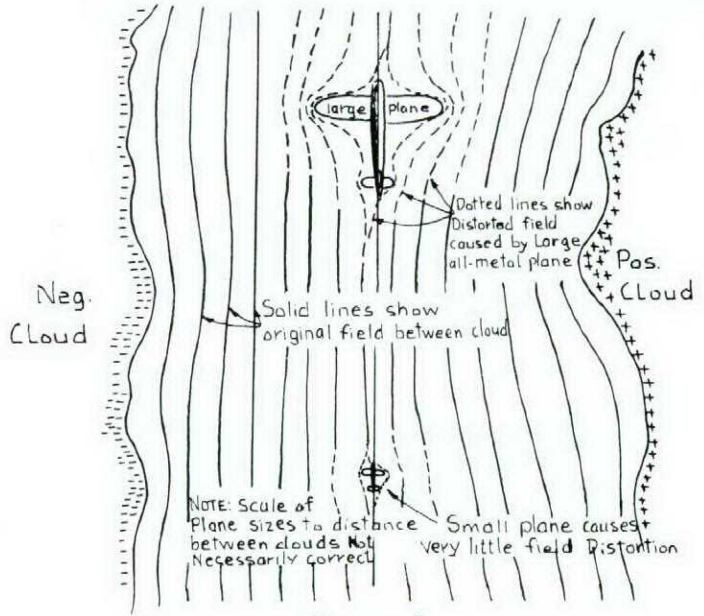


Figure 1

Plan view of effect of electrostatic field of planes between charged clouds.

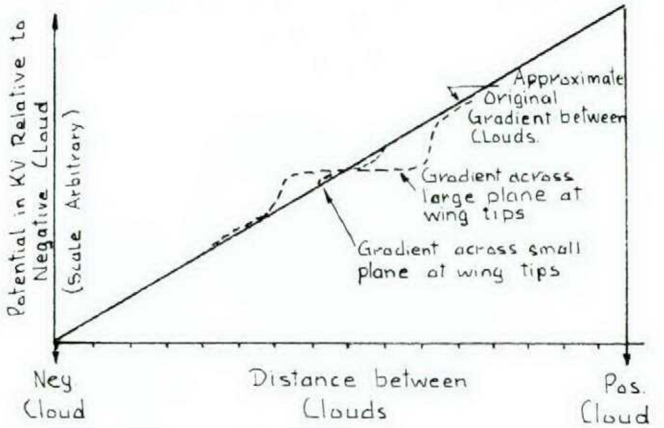


Figure 2

Effect on electrostatic field of planes between charged clouds

With regard to the temperature range, the zero electric potential zone of thunder clouds is approximately coincident with the 0°C isotherm. Across this zone most cloud-to-cloud discharges occur. Obviously this boundary is lower in winter than in summer.

The Argus has been dealt with at some length because it is the aircraft primarily involved with static discharge. Two problem areas stand out: the operational environment and the structure (such as paint, the huge plexiglass nose, etc). Hopefully these problems will be eliminated in the replacement aircraft.

HAIL

Hail damage is a well known and well publicized problem. Radar equipped aircraft can avoid hail, but it is a technique that must be taught. A new film on the subject, entitled Airborne Weather Radar (CF film number 23047), is available through the regional film libraries at Trenton and Winnipeg.

The forecaster can predict areas in which towering cumulus and CB clouds are present, and the amount to be expected. However, since these generally appear embedded when flying at low altitude, their exact position is better determined by radar.

cont'd on next page

Some Sources of Hazardous Wx Info.

CANADA

In Flight

Pilot to Forecaster Service 344.6 308.8
Military Aeronautical Communications Service (MACS)
Aeradio Stations Sigmet Information – Broadcast on receipt and on regular broadcasts
Aeronautical Station – Gander (shared frequency with New York) SIGMET information every 10 minutes during broadcast.
Transcribed wx broadcasts – Abbotsford, Montreal, Toronto, Vancouver
NORAD Radar Advisory (Any NORAD Region HQ in Canada or U.S.) 364.2

On The Ground

Contact the Wx Office
Contact Base Ops
Automatic Terminal Information Service (ATIS)

USA

In Flight

Pilot to Forecaster Service 239.8, 342.5, 344.6, 375.2
FAA Transcribed Wx Service (TWEBS)
Air Route Traffic Control Centres (ARTCC)
Enroute Wx Advisory Service (EWAS)
Radar Stations
Aeronautical Stations – SIGMET information broadcast by New York every ten minutes and by San Francisco and Anchorage every hour.

On The Ground

Contact the Wx Office
Contact Base Ops
Automatic Terminal Information Service (ATIS)

On the Dials

In our travels we're often faced with "Hey you're an ICP, what about such-and-such?" "Usually, these questions cannot be answered out of hand; if it were that easy the question wouldn't have been asked in the first place. Questions, suggestions, or rebuttals will be happily entertained and if not answered in print we shall attempt to give a personal answer. Please direct any communication to: Base Commander CFB Winnipeg, Westwin, Man. Attn: ICPS.

Recently we have received numerous inquiries concerning straight-in non-precision approaches, specifically the descent portion from the Final Approach Fix to the MDA. This article explains certain peculiarities on the let-down charts and perhaps will clarify or correct some areas.

To begin with, CFP 148 (Para 2903) and AFM 51-37 (USAF) are often compared with respect to instructions on the descent to MDA. AFM 51-37 states, "Descend to the MDA so that visual reference with the runway environment can be established as early as possible before reaching the Missed Approach Point". Next, CFP 148 states "During a straight-in approach the rate of descent from the facility inbound to the aerodrome must be high enough to allow the aircraft to reach the minimum altitude at or before visibility limits". There is a difference in wording which suggests two different techniques to descend to MDA. One states to reach MDA "as early as possible", the other states to reach MDA "at or before visibility limits". Which one should we use?

The new edition of CFP 148 will state that the pilot should be at MDA before visibility limits. We recommend thirty seconds to one minute early. The pilot should use sufficient rate of descent to ensure this. It will be to the pilot's advantage to arrive at the MDA prior to reaching his visibility limits; he could then, once runway environment was identified, descend from MDA to touch down at a rate normally used for a two- to three-degree glide slope. Bear in mind that the purpose of a non-precision approach is not to place the pilot on a glide slope but to allow him to descend to an altitude below the base of the cloud or to where his slant range visibility is at or in excess of his visibility requirement.

To complete this article, here are three questions received lately at the ICP School:

Q. Why does the approach chart graphically illustrate the flight path as reaching MDA over the missed approach point?

A. This is misleading and has been discussed between ourselves and MOT. A new approach plate format has been accepted and the side view will show the aircraft descent levelling off at MDA prior to MAP.

Q. Why doesn't CFP 148 put more emphasis on descending to MDA as soon as possible so as to intercept a normal glide path?

A. Two points arise here: First, what is to be interpreted by "as soon as possible"? Max rate IFR Descent? 1000 FPM or 500 FPM? As you see we could run the risk of gross misinterpretation. The second point, already mentioned, is that a non-precision approach is not directly related to a 2.°, 2.5° or 3.° glide slope. What it should and will relate to is descent gradient, i.e. the maximum distance per NM the aircraft will be required to descend from facility crossing altitude to the threshold. By interpolation this same figure will relate MDA above ground level to visibility and will depend on various aircraft categories. This concept is particularly employed in GPH 209 page 40 Table 7-1 and will be developed further in the revision.

Q. Why is the MAP not specified as a distance from the final approach fix beyond which it would be too dangerous to attempt a landing?

A. As already mentioned, this will depend on aircraft category and visibility requirements as well as runway length.

We hope we have clarified some of the problem areas dealing with descents to MDA. We will always answer any question submitted to the school, either directly by letter or in future "*On the Dials*".

Hazardous Weather

The problem of avoiding hail damage involves (a) hail prediction, (b) hail detection, and ultimately, (c) hail elimination. During the last decade progress has been made in the first two phases of this problem, and a better understanding has been acquired of the third.

Airborne radar should be utilized to fly a safe path.

SUMMARY

The April 1972 issue of the MAC Flyer provides a good summary of what flight crews can do when encountering lightning and hail conditions. They are warned that compass readings may become unreliable due to the magnetic susceptibility of ferrous metals.

The obvious means to avoid such conditions is to stay clear of thunderstorms. But this is not always possible, especially for military aircraft on operational missions.

A pilot runs the greatest risk of encountering a lightning strike is when he is flying below 20,000 feet, especially between 5,000 and 10,000 feet. Eighty percent of strikes occur between -10°C and + 10°C. As mentioned earlier, the avoidance of flight at or near the freezing level will greatly lessen the chance of static discharge, or an attracted strike.

There is a wise adage on the subject: *Don't use RADAR to find out why it's rough–use it to avoid areas where it may be rough.*

Flashback

Here's a tale of woe from our accident files of 1947. It shows among other things that pressing-on VFR into deteriorating weather is a pilot pitfall with longstanding precedent. Nor was it the last time that imprecise communications between a lead and his number two brought on an embarrassing development.

The formation of two Seafires was flying to the east coast. Along the way the weather began to deteriorate and soon the ceiling was down to 300 feet in places. ETA for their planned refuelling stop at Presque Ile passed, with the only indication they were near destination being another aircraft's transmission to Presque Ile, but they were unable to establish radio contact with the Tower. Nevertheless, they flew on, well beyond ETA (and well beyond the extent of their maps). At last they spotted a town which they were able to positively identify (thanks to the CNR station) as Campbellton N.B., 110 miles beyond Presque Ile. With fuel now running short they flew south along the New Brunswick coast looking for a landing field, and eventually found a group of hangars near Bathurst. A low level recce revealed a runway covered with packed ice and snow, and the only landing aid, a wind sock wrapped firmly around its mast.

After they inspected the runway, Number Two called, "Will you have first go, or will I? ". Lead replied, that he would "have first crack at it", however, Number Two understood him to say, "Have a crack at it". The upshot was that both did, at the same time – and from opposite directions! Number Two later described what followed: "I flew a normal approach from 400 feet at 80 knots, slowing to 70 knots over the end of the runway. I touched down on the very edge and when I felt I had the aircraft under control, I called Lead and said, 'I think I've made it' – but as I said it, we collided... The left wings of both our aircraft were sheared off and we were spun around 180°."

Lead's account was similar: "...I touched down in the middle of the runway and was rolling to a stop when I heard Number Two say 'I think I've got it made'. Then we collided..."

The only eye witness report read as follows: "I saw two aircraft circling as I was coming up the road leading to the field... One aircraft came in to land over me, flying in a westerly direction; the other aircraft I did not see coming in... Soon after, I saw pieces of aircraft flying into the air, followed by the noise of the collision."

engineering specifications…

A Forgotten Safety Factor

by Capt D.J. Batcock

An often forgotten, but very important safety factor in aircraft manufacture and repair, is the requirement that each one of the millions of pieces involved must meet an approved *specification* or precise standard.

The requirement to meet a specification is not solely applicable to the aviation business, nor is it something new and wonderful; the Bible gives specifications for buildings, food and other products, and the Society for Automotive Engineers has been issuing specifications since automobiles first became popular.

A specification clearly and accurately describes the essential and technical requirements of an item, and the procedures by which it will be determined that these requirements have been met. The purpose is two-fold: to compel the purchaser to consider in detail what he requires, and to convey these specific details to the manufacturer. The technical requirements of a specification vary:

- Materiel design and method of manufacturer
- Methods of inspection and test
- Sampling inspection and testing methods
- Qualification and approval tests
- Acceptance and rejection criteria
- Packaging.

These may contrast in complexity, from the simple paper clip (which would be nothing more than a drawing) to a complex missile system, the specification for which might be two or three volumes thick. The following extracts from common aircraft equipment specifications indicate the depth and tolerances required for aircraft equipment:

Bolt, Machine, Hexagon Head – Spec MS-9493 (Fig I)
"The shank shall be straight within .0025 inches total per inch of Bolt length.
"Fluorescent Penetrant inspection as per AMS 2645"
"Dimension in inches – tolerance"
– linear dimension $\pm$ .010"
– angular dimension $\pm$ 5°

Gasket, common, tail position light – AN 3119 (Fig II)
All dimension in inches – tolerance $\pm$ 1/64"
Indicator, Airspeed, Pitot/static type L-7A MIL-1-5356A (USAF) Fig (III)

Comprised of 16 pages and makes reference to 9 other specifications. Includes qualification, test acceptance, test and sampling, test procedure, as well as dimensional details.

The items selected each have a different specification number, indicating that there are many different types in use in the aviation business, however the most common are U.S. Military Specifications, normally referred to as *Mil Specs*. They are in fact specifications established by the USAF, USN etc, and may or may not be coordinated. As an example, MIL-B-4000 (USAF) covers a specification particular to the USAF only, whereas MIL-B-4000 would indicate a spec coordinated and agreed upon by all U.S. military agencies. Common aircraft hardware such as nuts, bolts and washers, will often be manufactured to an 'AN' Specification (Fig V). Originally issued by the Aeronautical Standards group of the U.S. Munitions Board, these are now being reissued as *Mil Specs* and the majority of the data is covered by an appropriate drawing. In Great Britain a similar method of specification is used, however, they also have the British Standards Institute which approves all specification written in Britain which have been standardized between various industries and manufacturers. These specs cover all items, not just items used in the aeronautical field. Aeronautical Equipment meeting a certain specification may or may not be interchangeable with equipment of another specification – before this is done appropriate engineering authority *must* be consulted to ensure strength, dimensional clearances, adequate testing and reliability have been considered. As a result of specifications, a standard has been established in the aviation business which theoretically ensures that the structure of an aircraft, its operating components and other ancillary components are all manufactured to well-defined requirements which have been carefully designed and approved by engineers, stress analysts and so on. This permits the final design authority to state, "The aircraft is safe". However if these standards are compromised after manufacture – for example, by the use of a standard machine bolt from the local hardware store instead of the approved aircraft bolt made to a specification – the result is that the chain now has a weak link and accident potential exists. The reason? Although bolts from the local store have been made to a specification (they wouldn't all be the same length otherwise), there is no requirement for the specification to be as refined as that used for aeronautics. As an example, aircraft bolts manufactured to AN standards have an ultimate tensile strength of 125,000 lbs to 145,000 lbs, whereas common american standard bolts of comparable size have an ultimate tensile strength between 8,000 lbs and 15,500 lbs depending upon size and materiel – a significant difference, particularly if this bolt happens to be holding a wing to a fuselage.

In summary, all component parts of an aircraft are manufactured to rigid standards called specifications. When this is done the machine is mechanically safe. Employing non-standard parts which don't meet approved specs to expedite repairs or meet commitments, creates a weak link in the system.

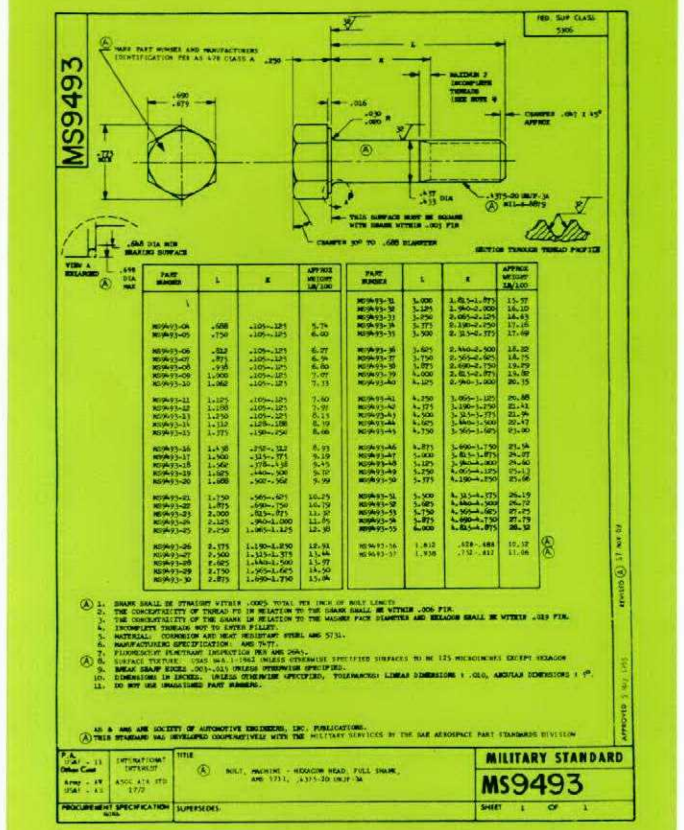
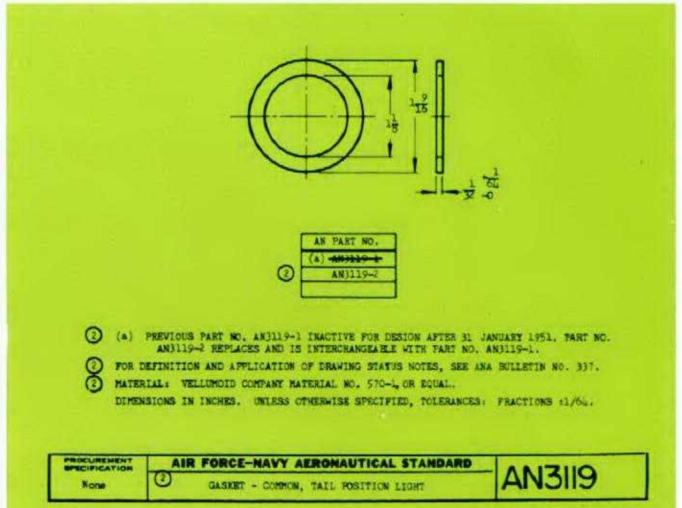


Fig I



② (a) PREVIOUS PART NO. AN3119-1 INACTIVE FOR DESIGN AFTER 31 JANUARY 1951. PART NO. AN3119-2 REPLACES AND IS INTERCHANGEABLE WITH PART NO. AN3119-1.
② FOR DEFINITION AND APPLICATION OF DRAWING STATUS NOTES, SEE ANA BULLETIN NO. 337.
② MATERIAL: VELLUMOID COMPANY MATERIAL NO. 570-1, OR EQUAL.
DIMENSIONS IN INCHES. UNLESS OTHERWISE SPECIFIED, TOLERANCES: FRACTIONS ±1/64.

PROCUREMENT SPECIFICATION	AIR FORCE-NAVY AERONAUTICAL STANDARD	AN3119
None	② GASKET - COMMON, TAIL POSITION LIGHT	

Fig II

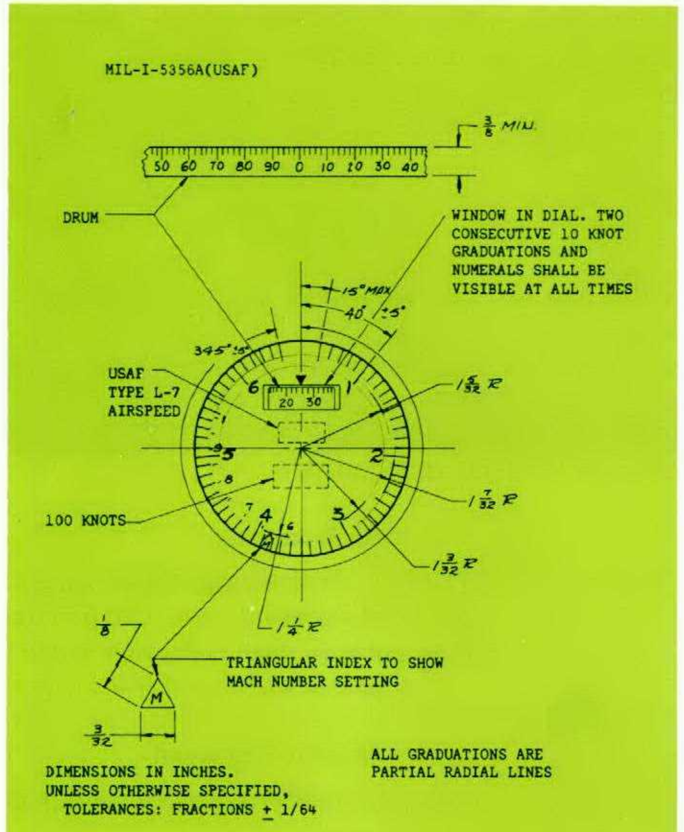


Fig III

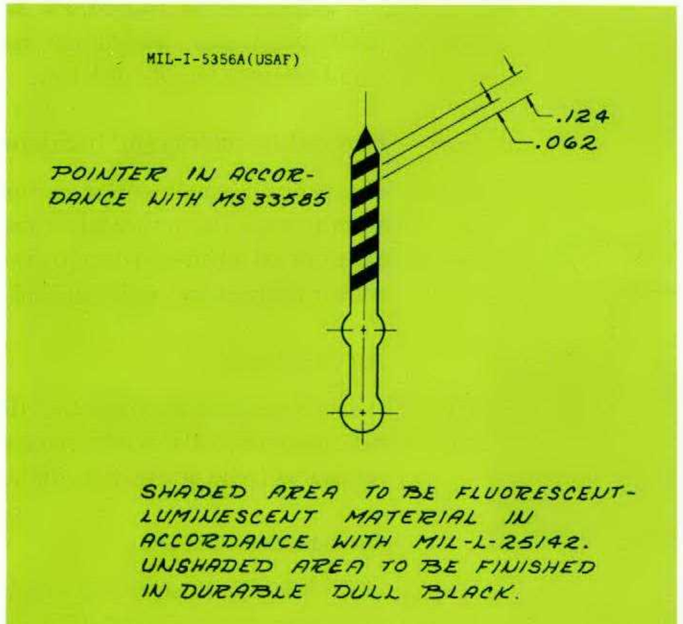


Fig IV

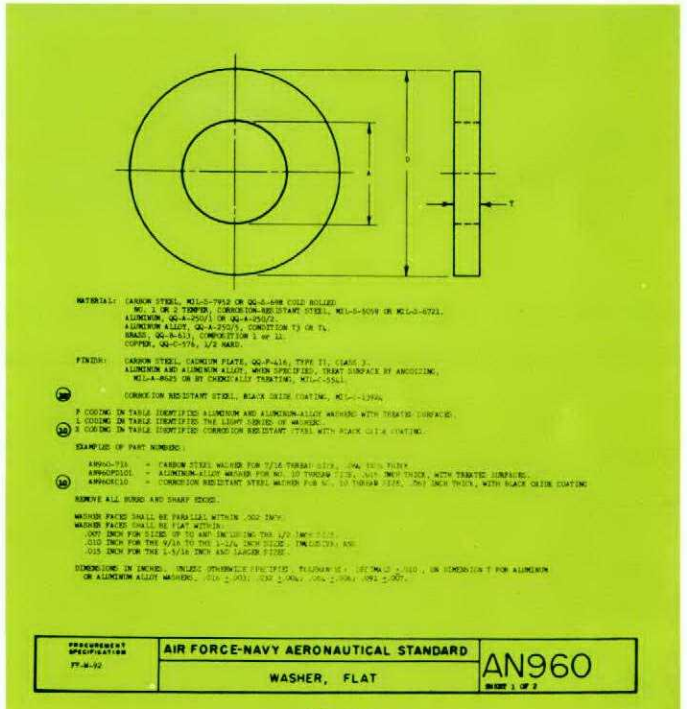
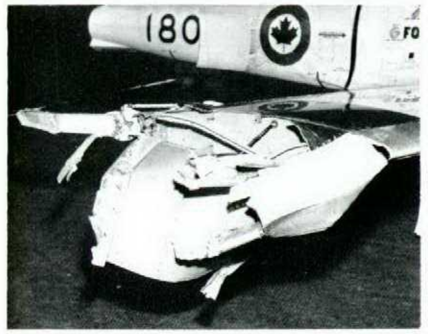


Fig V

the '72 story



The highlights of our 1972 accident and incident record are presented here. A detailed analysis has been completed and appears in the 1972 Annual Aircraft Accident Analysis.

Milestones

- The 1972 accident rate and the total number of accidents was the lowest ever.
- There were fewer ejections than in any year since the introduction of ejection seat equipped aircraft. The success rate was 100 per cent for ejections attempted within the ejection envelope.
- The number of fatalities in 1972 was an all-time low.

Air Accidents

The chart shows a total of 26 accidents – the fewest in any year since 1949. Our accident rate was 0.80 per 10,000 hours, down from 1.17 in 1971. During 1972 there was a small reduction in the total number of flying hours – a continuation of the general downward trend over the past 17 years.

Aircraft Destroyed

Seven accidents resulted in writeoffs – down from 15 aircraft destroyed in 1971.

Fatal Accidents and Fatalities

The 1972 record of four air accidents involving fatalities was identical to 1971. However, based on records back to 1 Jan 1946, the 1972 total of four fatalities was an all-time low.

Ground Accidents and Incidents

The Canadian Forces sustained six ground accidents and 252 ground incidents. Of the reported ground occurrences, 155 resulted in damage to the aircraft. The number of injuries rose to one major and 21 minor – a significant increase from 9 minor injuries in 1971. All told there were 50 vehicle strikes on aircraft.

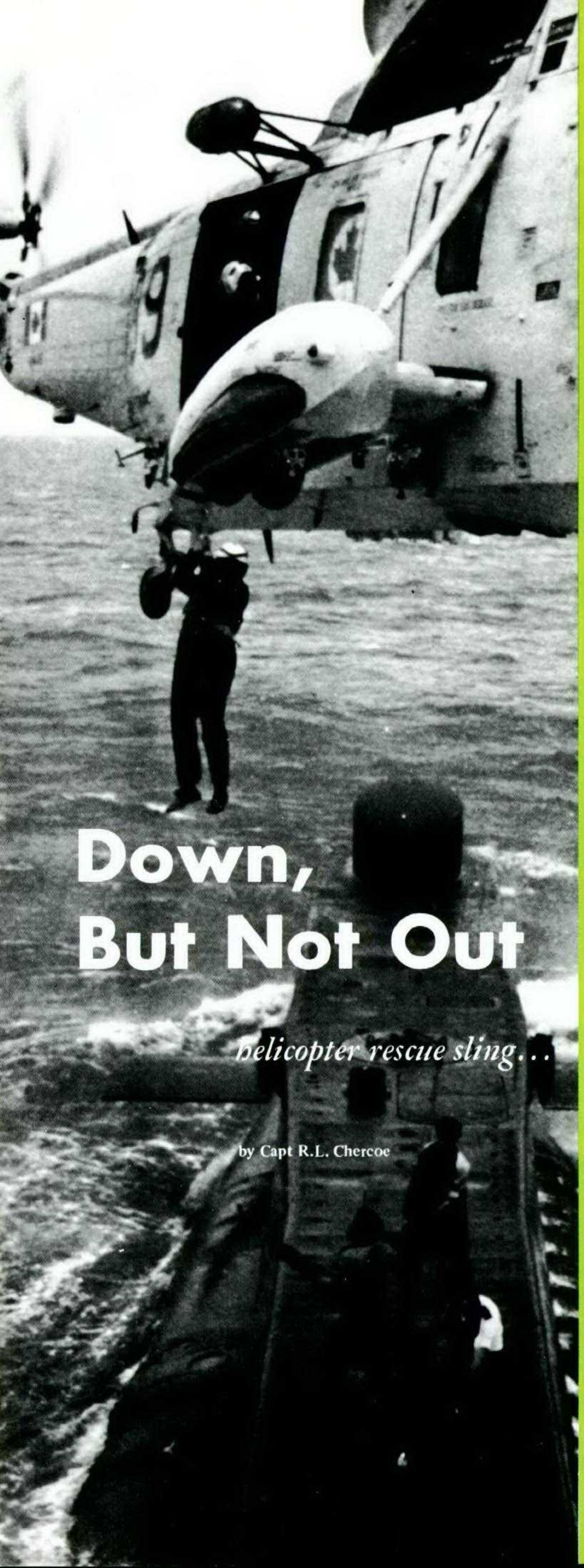
Air Incidents

Reported air incidents decreased in 1972 to 2567, down seven from 1971. This extensive use of the reporting system is important; the reports often enable preventive measures to be applied in time to prevent an accident.

Air Accident Causes

The 26 air accidents in 1972 were assigned 59 cause factors. Forty-four causes, a reduction of nine from 1971, were assigned to PERSONNEL. Next came MATERIEL, with six, followed by ENVIRONMENT with six. The remaining three cause factors were listed as UNDETERMINED.

	T33	CF104	CF101	CF5	CF100	TUTOR	ARGUS	CUH-1N	CH113A	SEA KING	HERCULES	DAKOTA	BUFFALO	TOTALS
Destroyed	1				1	2		2		1				7
B Cat										1				1
C Cat	3	4	1	1		1	2	1		1	1	1	1	17
All Acc	4	4	1	1	1	3	2	3	1	3	1	1	1	26
Fatalities	1					2			1					4



Down, But Not Out

helicopter rescue sling...

by Capt R.L. Chercoe

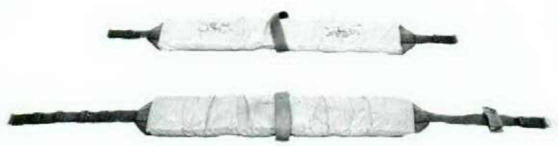
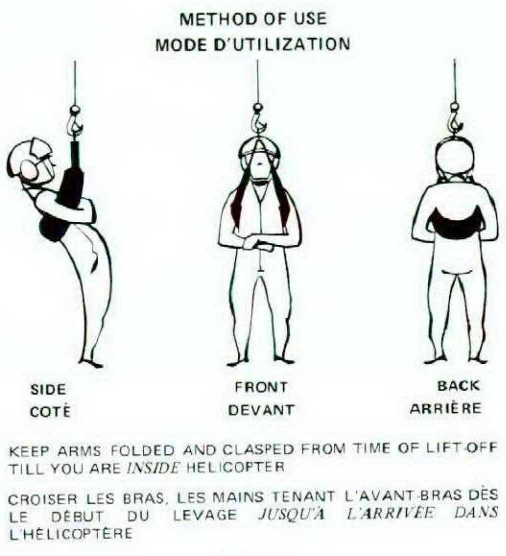


Fig A.



KEEP ARMS FOLDED AND CLASPED FROM TIME OF LIFT-OFF TILL YOU ARE *INSIDE* HELICOPTER

CROISER LES BRAS, LES MAINS TENANT L'AVANT-BRAS DÈS LE DÉBUT DU LEVAGE *JUSQU'À L'ARRIVÉE DANS* L'HÉLICOPTÈRE

Fig B.

Canadian Forces rescue capability is about to be enhanced with the introduction of a new helicopter rescue sling. This so-called "Standard" sling (the Billy Pugh net will continue to be used) will be available in two models, formally identified as:

a. Sling, Rescue, Personnel, Long, Helicopter,NSN 1670-21-860-4565; and

b. Sling, Rescue, Personnel, Short, Helicopter, NSN 1670-21-860-4566.

The common terminology for each sling will be "Helicopter Rescue Sling long" or "Helicopter Rescue Sling short" as the case may be. Engineering Orders for the new slings may be found in EO 55-45A-2.

The requirement for both a long and a short rescue sling stems from differences in helicopter hoisting systems. At present the CF operate four different types of helicopters with hoisting capabilities, each with different winch configurations, eg, externally mounted, internally mounted, and boom mounted. The short rescue sling is to be used by all SAR squadrons and in helicopters with internally mounted hoist booms and/or cable pulley attachment points. The long sling is to be used in all helicopters with externally mounted hoists, for shipboard rescues, and for other applications where use of the short sling is impractical. Therefore, if you are being rescued by a CH113 Labrador, a CH113A Voyageur, a base rescue CUH-1H Iroquois or a CUH-1N Twin Huey, expect a short sling to be lowered to you. If you are being rescued by a Sea King, expect a long sling. There is a slight difference in operating procedure which is explained later in this article.

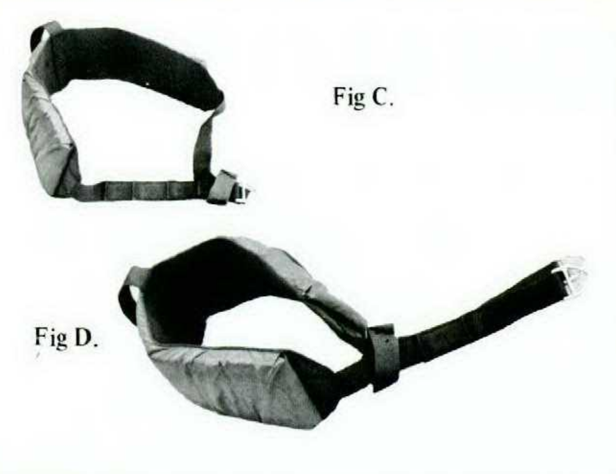


Fig C.

Fig D.

Fig G.

Fig H.

Fig E.

Fig F.

Fig J.

Fig K.

Both the long and short slings, illustrated in Fig A, are made of nylon and cotton material. Attached to the main nylon lift riser is a length of six-inch wide cotton webbing to which is fastened a closed cell "Ensolite" pad covered with a bright polyester material. The Ensolite pad provides flotation for the sling. A loop on the center of the sling enables crewmen to assist persons being hoisted on board. Instructions for donning the sling are printed in English and in French on water proof material, and attached to the inward facing surface of the sling (see Fig. B). The short sling is 52-inches long while the long one extends 72 inches. Because of the longer risers on the long sling, a "keeper" is employed and is held in place by a unique retention system. One layer of one riser is folded and sewn at intervals as shown in Fig C. The keeper system is used to reduce the diameter of the sling and thereby to ensure a better and safer fit (see Fig. D).

Helicopter crews will manoeuvre into position and lower the rescue sling. Care must be taken not to touch the uninsulated portion of the grounding chain which is attached to the rescue hook since a build-up of static electricity could cause a severe shock. To protect persons being rescued, the upper seven-foot portion of the grounding chain is covered with a plastic insulating sleeve while the remaining portion is left bare to dissipate any static build-ups. Once the survivor grasps the rescue sling, it should be donned quickly. The recommended method is to slip the sling over the head and then bring both arms up over the sides. When the sling is donned, the hands are folded and clasped in front of the body as illustrated in Fig E and F (Note that the hand position in the title photograph is incorrect). The same method is used to don the long rescue sling except that the keeper must be adjusted after the sling is donned. The adjustment is accomplished by pulling the keeper down until it is past the lowest possible fold in the riser and then slowly lifting the keeper until it slides under the desired fold. The person's weight will place tension on the risers and hold the keeper in place. Again, fold and grasp the hands in front of the body as shown in Fig G and H. Once in the sling with arms grasped in front of the body, maintain this position until INSIDE the helicopter. Do NOT reach up in an attempt to hang onto the hoist cable or sling risers since raising the hands over the head could result in slipping out of the sling. While the sling is capable of hoisting an unconscious person (see Fig J), it is safer to hold the arms clasped in front of the body. Once winching is complete, the crewman will haul the survivor into the aircraft by grasping the web loop at the back of the sling and sliding him on his buttocks as illustrated in Fig K. Note that in this photo the survivor's arms are not in the recommended position because, in this particular case, the "survivor" was feigning unconsciousness. During the haul-in phase of the rescue, it is important that the survivor maintains his position and does not try to climb into the helicopter by grabbing at the crewman or helicopter door. *Remember – once in the sling, the survivor's responsibility is to remain securely in the sling until he is inside the helicopter.* ■

ROTORWASH

AUTOROTATIONS CAUSE & EFFECT

by H.E. Roland Jr.

. . . the modern military pilot,
with so many demands
on his time, may find it
easy to rely on rather superficial
aids to understand
his aircraft and its reaction

All too often near misses and accidents involve practice autorotations. The balance of forces acting in the autorotation manoeuvre is not commonly understood in its entirety. However, the interaction of forces and helicopter reaction is not too complex and can be reviewed in a fairly simple manner. A total understanding of the forces acting is the first step towards performing a predictable, well controlled manoeuvre.

Autorotation is the method by which the pilot lowers the powerless helicopter through the atmosphere at a reasonable rate of descent, using the energy of gravity to maintain main rotor rpm and, through it, tail rotor rpm and control. During this descent, a certain portion of this energy is stored in the main rotor where it may be called upon to further decrease the rate of descent at the proper moment, just before touchdown.

It might be well to first examine the establishment of rotor rpm. The action of a windmill is well known and the rotation of the rotor is not surprising. If the rotor is orientated at a sufficiently large negative angle of attack, it will be immediately assumed that it will rotate, replacing the torque which was imparted to it by the engine, with aerodynamic forces. Of interest to our fledgling pilot is selection of the proper rpm for maximum resistance to the passing of the rotor and the forces which maintain this rpm. Figure 1 illustrates the simple windmilling airfoil and the forces which maintain its rpm.

It can be seen in figure 1 that L_h is greater than D_h and, therefore, the airfoil will accelerate or the rpm will increase. As this occurs, the direction and magnitude of the relative wind will change. In turn, this will alter the magnitude of both lift and drag. As the rpm continues to increase, L_h will decrease and D_h increase until they are equal. At this particular rpm, the airfoil will be in equilibrium and the rpm will remain constant. If the angle at which the airfoil is set could be altered, the equilibrium could be established to any desired rpm within reason.

Within the total helicopter rotor, the situation is similar to this simplified picture, but somewhat more complex. A blade angle setting will be selected with the collective which will give a desired rpm and, with this rpm, the greatest resistance to the passage of the rotor in its descent, consistent with the desired energy to be stored for the flare for landing. The resistance or lift generated by the powerless rotor can be amazingly large – approximately equal to that of a parachute of the same diameter.

However, in the real rotor, the V_{rpm} varies along the radius of the blade, while the vertical velocity remains constant. This means that the relative wind is constantly changing along the radius of the rotor blade. If the entire rotor disc is examined, it can be easily divided into three general regions. A small region in the center of the disc is stalled. In this region the angle of the relative wind with respect to the blade is quite large. This is caused by the very small V_{rpm} at the short radius. Outside the stall region is found the autorotation region. In this region L_h is greater than D_h. The autorotation region then is providing a net force to accelerate the rotor.

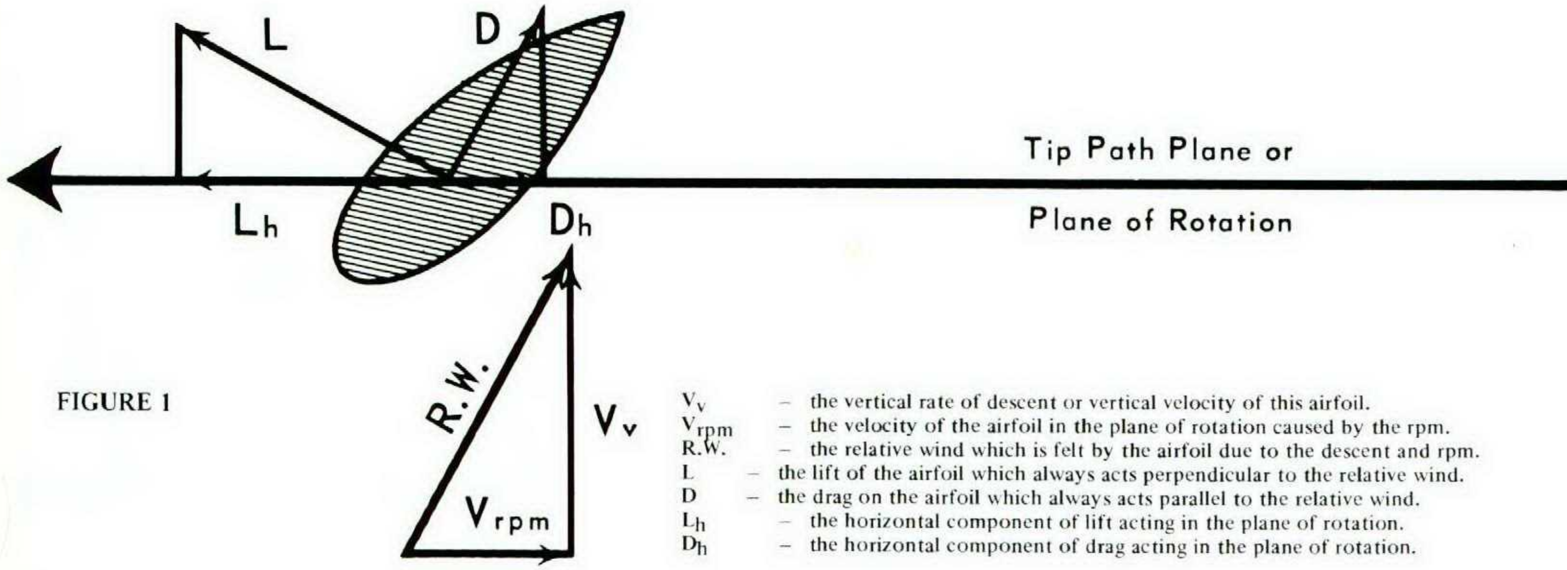


FIGURE 1

V_v – the vertical rate of descent or vertical velocity of this airfoil.
V_{rpm} – the velocity of the airfoil in the plane of rotation caused by the rpm.
R.W. – the relative wind which is felt by the airfoil due to the descent and rpm.
L – the lift of the airfoil which always acts perpendicular to the relative wind.
D – the drag on the airfoil which always acts parallel to the relative wind.
L_h – the horizontal component of lift acting in the plane of rotation.
D_h – the horizontal component of drag acting in the plane of rotation.

AUTOROTATIONS

. . . a lot of bar talk is heard concerning the forward speeds of autorotation. The high rate of descent in vertical autorotations is well known, but what is it that causes this?

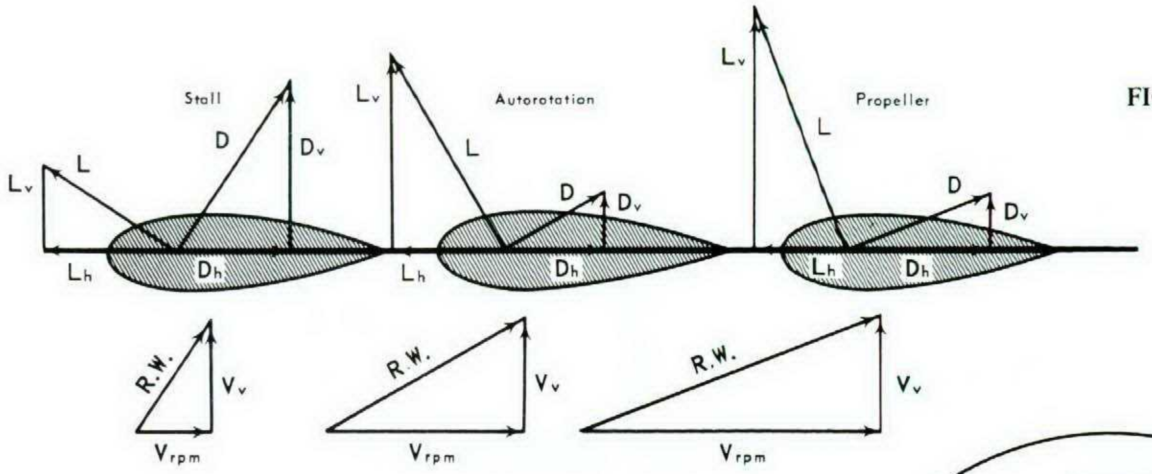
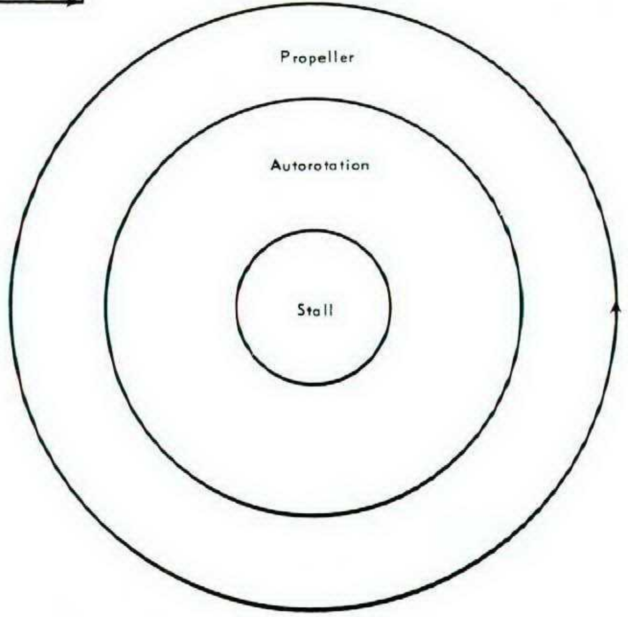


FIGURE 2



Near the circumference of the rotor disc is found the propeller region. In this region the V_{rpm} is quite high due to the large radius. The distinguishing feature of this region is that the D_4 is greater than L_4 so that this region contributes a net force to decelerate the rotor. These regions, their typical airfoil sections, and the accompanying aerodynamic forces are shown in figure 2.

Figure 2 represents a condition of vertical autorotation. The stall and autorotation regions will be displaced slightly during autorotation at some forward speed.

Once the pilot selects a blade angle with the collective, the propeller and autorotation regions are established in such a way that their respective unbalance of forces are balanced against each other and the rpm of the rotor stabilizes. If the collective remains set at this position, the rpm will always return to the same value, even if momentarily increased or decreased by gusts.

The lift of the rotor is represented by the vertical values of lift and drag down as L_V and D_V. It can be seen that all regions of the helicopter rotor disc furnish lift, but the propeller region contributes the majority of the lift.

Fortunately, the pilot does not need to experiment with the collective to find the optimum setting to minimize the rate of descent. The manufacturer specifies the optimum rpm for autorotation and it is only necessary for the pilot to select this rpm by balancing forces in the rotor disc with the collective position.

It might be well to examine for a moment the danger inherent in the establishment of the correct rpm at the time of power loss. When power is lost to the rotor, the collective will be up and the angle of all blades will be high. This will tend to make the majority of the rotor disc become a propeller region. The aerodynamic forces cannot be balanced under such conditions and the rpm will steadily and quickly decay. If the rpm decreases to a very low value before the pilot takes action, lowering the collective will not provide the forces necessary to accelerate the rpm. The V_{rpm} will have decreased to such a low value that the angle of the relative wind will remain high throughout the disc and the rpm will continue to decay. Recovery may be effected prior to loss of control if forward speed is increased by diving. In this case altitude must be sacrificed.

A lot of bar talk is heard concerning the forward speeds of autorotation. The high rate of descent in vertical autorotations is well known, but what is it that causes this? The engine imparts torque to the rotor and the torque, combined with the rpm of the rotor, can be computed as horsepower. A simple plot of the horsepower needed to drive the rotor at its autorotation rpm at all forward speeds may be made. Figure 3 shows a typical plot. It can be seen that more horsepower is required to autorotate at zero knots forward speed than at moderate forward speeds. As the speed continues to increase, the power reaches a low point and then begins to increase, eventually reaching a value which is greater than that of zero forward velocity.

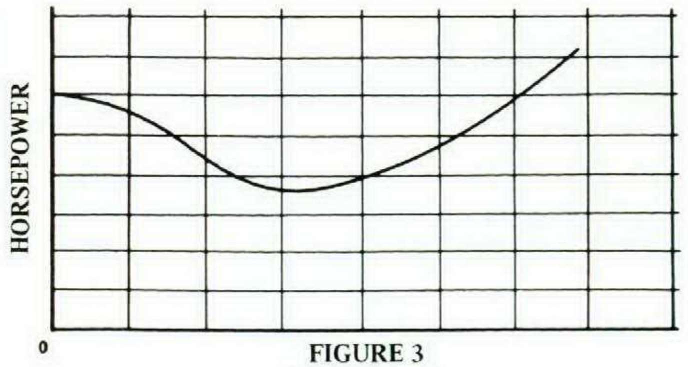


FIGURE 3
Velocity-Knots

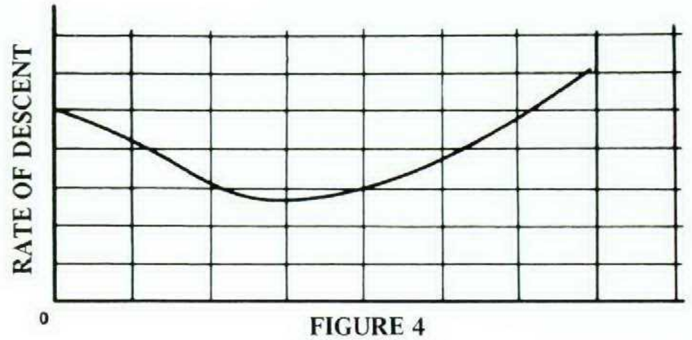


FIGURE 4
Velocity-Knots

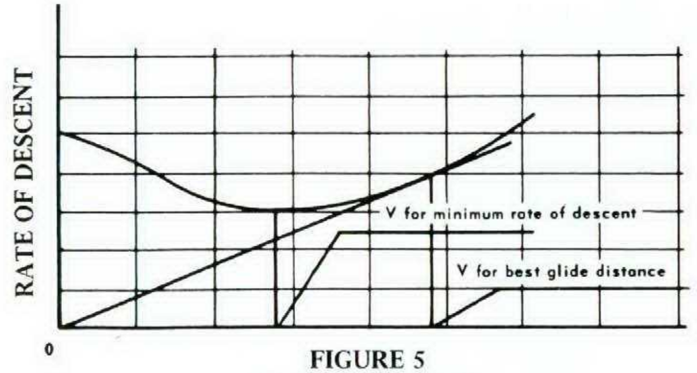


FIGURE 5
Velocity-Knots (TAS)

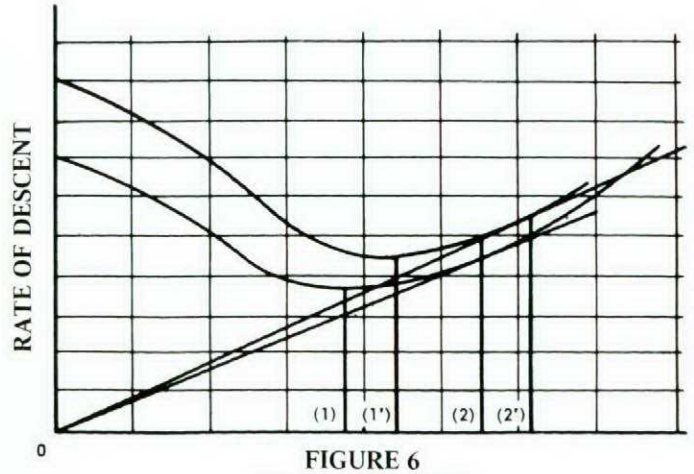


FIGURE 6
Velocity-Knots (TAS)

During autorotation, such power as is available is furnished by gravity. As the force of gravity remains constant on the helicopter of constant weight the power furnished by gravity will be constant. Therefore, the lack of horsepower, which may be converted to rate of descent at any given forward speed, will be less at some moderate forward speed than at zero forward speed. If rate of descent versus forward speed is plotted, the shape of the curve will be very similar to the horsepower figure.

Thus it can be seen that the minimum rate of descent will occur at a moderate forward speed. The speeds implied in figures 3 and 4 are true airspeeds. If the autorotation is being made against a headwind, it would be possible to descend vertically over a point on the ground, with a rate of descent less than that indicated for vertical descent. A tailwind would have an opposite and more dangerous effect.

Operational considerations may cause the pilot to choose one of two types of autorotations, that for minimum rate of descent, or one which will provide the most distance covered over the ground for each foot of altitude available at the start of the autorotation. This is normally called the best glide performance. The rate of descent curve provides the key to each of these. As can be seen in figure 5, the low point of the curve is obviously the speed at which to maintain the minimum rate of descent. But what of the best glide speed? It must be some combination of slightly higher forward flight speed and rate of descent which does not sacrifice too much rate of descent.

Figure 5 shows that a line drawn from the origin of the plot and just touching the curve will indicate the best speed to glide for maximum distance covered during the autorotation. The triangle thus formed will establish the maximum velocity per rate of descent. A slower or faster velocity will decrease the ratio between the two quantities and decrease the distance glided from a given altitude.

The pilots' handbook will give the above speeds for the basic weight and standard density conditions. But what if conditions are nonstandard? In general, if the density altitude or gross weight is increased, the drag on the rotor blades is increased in such a way that the horsepower and, thus, the rate of descent will be indreased. Furthermore, the character of the curve will be altered slightly in that the points of interest will be moved to the right. Figure 6 illustrates this point.

Velocities at (1) and (1') represent the increase in speed for minimum rate of descent, caused by the increase in gross weight or density altitude. Velocities (2) and (2') represent the increase in speed for best glide performance at the higher weights or altitudes. If a pilot does not have the handbook figures in mind, he will know that a small increase in the basic speeds will place him close to optimum performance.

Execution of a safe landing from the autorotation descent will depend on the pilot's skill and judgment in recovering the energy stored in the rotor. The energy stored in the rotor is dependent upon the rpm and moment of inertia of the rotor. The higher the rpm, the greater the energy which will be available when the collective is raised. This moment of inertia may be compared to the swing weight of a golf club. A weight near the head will cause the club to swing heavy. A similar weight added near the handle will not make the same addition to the swing weight.

For this reason, helicopter rotors with long blades will tend to have better autorotation characteristics than short bladed rotors. Also, helicopters with light blades will have poor characteristics. However, this is only a generalization and other factors, such as rpm, can modify these conclusions. The modern helicopter is moving toward short heavy blades rotating at high rpm which, in sum, improves autorotation characteristics.

The modern military pilot, with so many demands on his time, may find it very easy to rely on rather superficial aids to understanding his aircraft and its reaction. Pilots' handbooks and simplified training manuals, as well as a fundamental knowledge of the forces of nature acting within the aircraft, are all necessary. The pilot who masters the simple engineering principles of his aircraft – who understands the why behind the reaction – immediately elevates himself to a new level of competence and safety.

Courtesy U.S. Army Aviation Digest

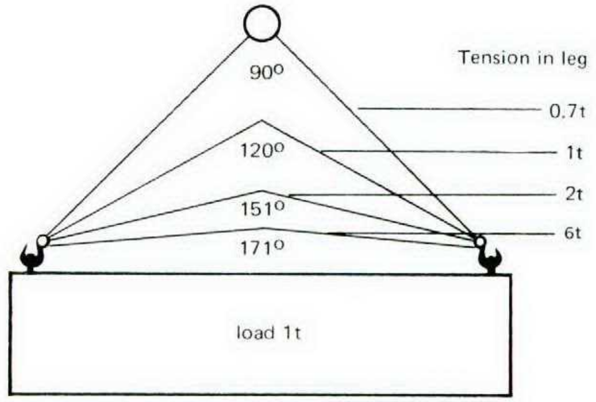
T33 Restrictions?

A positive G restriction placed on USAF and USN T33s has raised queries as to whether the restriction applies to CF T33s.

The restriction to three positive G came about as a result of a structural integrity study conducted by Lockheed. The areas of potential weakness, *revealed by testing a high-time USAF T33 to destruction*, are known to the Canadian Forces. These areas have either been strengthened as a result of various modifications during the service life of our T33s, or are regularly inspected during Periodic, Depot Level, and Sampling Inspections. Inspection procedures, including the Lockheed findings, are continually being examined and where necessary, modified to ensure the integrity of the aircraft.

Take Care of Your Chains, Gang

Before new sling chains reach your shop, they've been tested by the manufacturer to ascertain their capability to handle the working load limit. Rarely, will a new chain be unsafe – have any weak links. But through overloading, misuse and wear, expensive sling chains can be damaged and become hazardous.



Sling leg tension increases rapidly with change of leg angle

To take care of your chains:

- Inspect chains regularly and watch for elongation, or "reach" in chain terminology. Measure each leg. Look for deep gouges, bent links, badly abraded links, cracked welds, stretched links and damage to attachments.
- Check load charts and learn how to calculate the stress on chains. The stress on a sling chain increases considerably as the angle between the load and the chain decreases.
- Balance the load – unbalanced chains greatly increase the strain on one leg ot the sling.
  Hang chains up when not in use. Chains left lying about are subject to damage from trucks and other hazards.
- Clean chains regularly. Dirt and grit grind away at the links and shorten chain life.
- Do not anneal alloy chains. Return them to the manufacturer for repair and service. Avoid twists, kinks or loops when using chains – these factors reduce tensile strength.
- Check load seating before fitting – be sure the load is properly within the throat opening of the hooks.
  Never bounce or jerk the load when lifting or lowering.
- Shield links from contact with sharp corners of the load by using pads. Sharp edges can chisel the best chain causing stress, distortion and wear.

Through the application of new alloys, welding techniques and better design, modern chains are stronger and lighter, but maintenance and inspection on the job are still necessary to get the most from them in service and safety.

Safety Perspective

BIRD WATCHn from Two-Ten

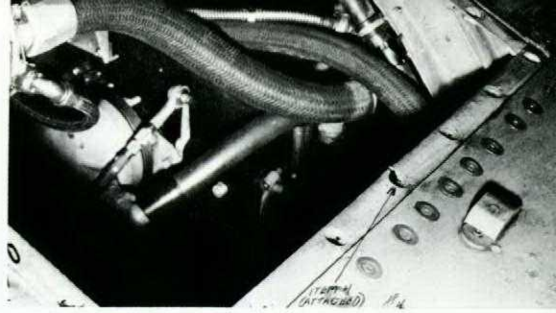
T33, ANOTHER PLENUM PANEL The aircraft was on the second leg of a cross-country flight. As the speed brakes were selected prior to descent at destination, the crew felt a thump and after landing they found that one of the lower plenum panels had opened and that the luggage carrier was missing.

An extensive investigation did not firmly pin-point the responsibility for the unfastened plenum panel. It appeared that most of the plenum panel dzus fasteners had not been locked prior to flight, but whether this occurred at home base or at the enroute stop could not be determined. The pilots claimed that they had inspected these panels closely in both instances, especially at home base where one of them was under the aircraft for some time assisting the ground crew in installing the luggage carrier. Only refuelling, oxygen and the normal BFI were carried out at the enroute stop and as far as could be ascertained, the plenum panel was not opened during the turnaround.

In the loss of the luggage carrier, evidence indicated that it had not been properly installed in the first place and the sudden opening of the plenum panel may have created enough turbulence and pressure changes to set it loose.

This incident gave rise to two inter-related events, both of which were preventable. Inattention on the part of ground and aircrew led to the panel coming open in flight, which in turn appears to have triggered the loss of the improperly mounted luggage carrier. The investigation brought to light a number of weaknesses in the maintenance system and resulted in action being initiated by the unit to prevent recurrence:

- A last chance inspection has been introduced to check aircraft for loose panels before they leave the line.
- The improper installation of the luggage carrier led to engineering changes aimed at eliminating the weaknesses in the system which made it possible. One of these was to replace an elbow-type fuel drain (which was not the approved EO design), thus allowing the carrier to more fully engage the latching mechanism. Another, and a more difficult problem, was to ensure that the clevis bolt in the latching mechanism protruded sufficiently. The lack of protrusion was suspected to be the result of tolerance stack between inter-related parts, especially as the carriers are not assigned to a specific aircraft.



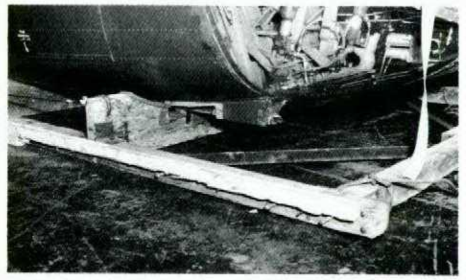
The condition of the fastener assemblies indicated that the panel was secured by only one fastener.

A significant sidelight of this mishap was that the less-than-satisfactory suspension system for the luggage carrier was a well-known and longstanding problem. But it was being lived with because no one had made the effort to institute a remedy.

VOYAGEUR, DOUBLE TROUBLE The helicopter had been damaged while on deployment and was being returned in two sections to home base for repairs. An L19 loader had been used to position the helicopter on board the Hercules, then the loader itself was put on a second Hercules which was to arrive back at base approximately two hours after the first.

When the lead aircraft reached destination the unloading crew found that they did not have proper equipment to remove the helicopter because their L23 loader was unserviceable. However, although they were advised that unloading equipment was following in the second aircraft, they decided that getting the Hercules on its way had priority. Thus, they improvised and eventually rigged a forklift for the task. What happened next was predictable. As they moved the main fuselage section off the aircraft loading ramp, the supporting cradle, which was being improperly used as a lifting cradle, broke, and in the ensuing drop to the tarmac the fuselage was further damaged.

Corrective measures resulting from this mishap include labelling of the CH113 cradle with a warning that it is not to be used as a lifting device and that when in use, the cradle skids are to be supported throughout their entire length. In addition, loading and unloading instructions for the CH113 and 113A are now being prepared for inclusion in the appropriate technical orders.



In summary, the causes were very basic. Faced with compromising between safety and effectiveness, the unloading crew were caught out by inadequate information, and lack of expertise, compounded by an understandable but misguided desire to hurry.

ARGUS, ATTACKED BY SANDER The aircraft had been towed out of the hangar and parked on an access taxiway. While the tow crew were in the process of chocking the wheels, a sander working in the area drove under the right wing, and the window grill of the partially-raised dump struck the aircraft. Last minute radio warnings to the driver were too late.

Although damage to the aircraft was relatively minor, this incident is disturbing in that it came about as a direct result of the sander driver ignoring safety precautions outlined in both Base and Section Orders. These orders explicitly prohibit vehicles from driving *"underneath any portion of an aircraft."*

Good Show


Capt M.F. Blair and Capt W.E. Books

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CAPT M.F. BLAIR AND CAPT W.E. BOOKS

Capt Blair and Capt Books were flying a CF101 training mission. Shortly after levelling off following a formation climbout, loud vibrations occurred when Capt Blair applied full power. It was immediately apparent to them that the vibration was coming from the area of the right engine, but they were unable to ascertain the cause as there were no compressor stall symptoms and all engine instruments read normal. Thus, unsure of the reason for the vibration, they shut down the engine as a precaution to prevent damage, and returned to base for a single-engine approach and landing.

Investigating technicians found that a blade had failed in the fifth stage of the forward compressor and had become lodged against the compressor casing. Had not the engine been shut down immediately, the blade might have gone through the engine, causing engine failure and fire.

By their quick response, Capt Blair and Capt Books averted the possible loss of their aircraft.

SGT H.K. HOWLETT

Sgt Howlett was the Duty Radar Controller at Summerside when a CF101, diverted from Chatham, declared a low fuel emergency. Summerside weather at the time had deteriorated to 500 and 2 in drizzle and fog, but it was the only field "open" within the fuel range of the aircraft.

When the aircraft was cleared for an approach, Sgt Howlett found that he was unable to establish an SIF return and directed the pilot to final approach using intermittent primary radar. The aircraft landed successfully with only five minutes of fuel remaining.

In his quick reaction to this emergency situation, Sgt Howlett demonstrated outstanding professional controlling as he coped with several problems at once. First, he had a minimum of time to locate and identify the aircraft as it was close to Summerside before the tower was informed of the diversion. Secondly, because the aircraft's SIF was not functioning and the primary radar target was intermittent, he was required to exercise great care and skill during the entire approach. And finally, in a minimum of time, he was required to vector the aircraft while simultaneously performing several radar alignments before directing the aircraft to a safe landing.

With fuel at a critical state, it was unlikely that the aircraft had enough for a second approach. Thus, Sgt Howlett had to ensure that everything was right the first time.

SGT M.R. MILLS

Sgt Mills was the Duty Radar Controller at North Bay when he received word that a light aircraft had encountered difficulties in deteriorating weather. The pilot, with three para-jumpers on board, had taken off in VFR weather from an airstrip 25 miles away, however the predicted general improvement in the weather failed to materialize; in fact it had deteriorated to thin obscured, 200 feet overcast and five-eights of a mile visibility in light rain and fog.

The pilot then declared an emergency and reported that his directional gyro had failed. With very little instrument experience and with conditions precluding his being vectored to an area of improved weather, he was handed off to Sgt Mills for a no-compass PAR to runway 26. Having never previously flown a precision radar approach, he experienced great difficulty in maintaining a proper rate of descent on final and in performing the required degree of turn for azimuth corrections. At three-quarters of a mile, with the aircraft outside the control limits for a safe approach, Sgt Mills gave guidance for a missed approach.

Although the aircraft had approximately two hours fuel remaining, it was becoming apparent to Sgt Mills that the pilot was in a very agitated state and that it was essential to complete the approach as soon as possible. With calm and reassuring directions, he directed him through a square pattern and instructed him as to the type of turns required on final approach. The second approach was successful and the pilot landed safely.

Sgt Mills' calm response to the emergency situation probably prevented the loss of this aircraft and its occupants.

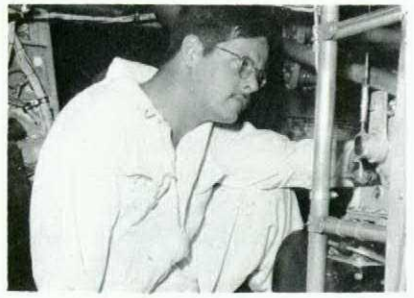
MCPL T.A. MARSHALL

Following a report of smoke in the cockpit in a Musketeer aircraft, MCpl Marshall and several technicians inspected the suspected area, with negative results. MCpl Marshall was not satisfied with these results and decided to carry out another inspection. This time his efforts were successful. He found that the metal core of the cockpit ventillation hose had worn through the outer layer of the hose and shorted against an electrical buss bar, causing the hose to burn. It had not been discovered earlier because the hose was no longer touching the buss bar.

The location of the hose and buss bar made it extremely difficult to pin-point the fault. MCpl Marshall's determination prevented a possible in-flight fire.

BIRD WATCHER


MCpl T.A. Marshall


MCpl A.S. MacLean


Cpl G.L. Walker


Mcpl R.A. Isbister


Pte J.M.C.S. Doucet

MCPL A.S. MACLEAN

MCpl MacLean, an IE Tech, was in the pilot's seat of an Argus while it was being towed. As the aircraft was moved along, he detected what he felt to be an unusual feel in the elevator controls when he moved the control column. After the aircraft was parked and the noise of the towing had subsided, his suspicion that something was amiss was amplified when he discerned a clicking noise as the elevator controls were moved. He immediately informed an airframe technician of his findings and an investigation soon revealed that the noise was caused by the elevator spring pot rubbing against the artificial feel hydraulic line. The line, which was almost worn through, had somehow been bent out of its normal position.

The consequences of this line being ruptured in flight were twofold: first, the artificial feel would be lost, necessitating extreme caution in pitch control to avoid overstressing the aircraft; and secondly, there was the possibility that the pin on the elevator spring pot could have stuck in the ruptured line, causing the elevator controls to jam.

MCpl MacLean's persistance in following up a suspected malfunction in an area not associated with his trade forestalled the development of a dangerous flight hazard.

MCPL R.A. ISBISTER

MCpl Isbister was performing the normal control check on a Kiowa following an adjustment of the tail rotor controls at the tail rotor gearbox, when he detected an unusual noise. He investigated further and discovered a control tube chafing against a metal channel mounted inside the centre post in the cabin.

One corner of the channel section had created a 1/8-inch wide, 2½-inch long gouge in the control tube. This could have resulted in eventual bending of the control tube or a failure of the control tube itself. In either case, partial or complete loss of tail rotor control would have ensued. Ironically, the channel had been installed by the manufacturer after quality control discovered slight oil canning on that portion of the centre post wall. Unfortunately, the solution of one problem created a greater one.

MCpl Isbister's conscientiousness averted what could have become a serious in-flight control problem.

CPL G.L. WALKER

Cpl Walker was carrying out flexible maintenance (flexible inspection card IE30) on a Tracker. During his visual check of the fuel quantity tank unit electrical leads on the inboard wing area, he noticed what appeared to be a crack in a feed line nut (on a line from the auxiliary tank) which was attached to the bulkhead connector. He then inspected the line on the other side of the aircraft and found a similar crack. When he reported his findings, the lines were removed and the cracks were confirmed. Inspection of six other Trackers at the unit uncovered a total of five additional cracked fittings.

Cpl Walker's attention to detail and his follow-up investigation prevented the possible outbreak of serious fuel leaks in the Tracker fleet.

PTE J.M.C.S. DOUCET

Pte Doucet was assisting with CF5 starts on a bitterly cold winter morning when he observed a CSU (Combined Services Unit) break free from its towing tractor and head directly for an aircraft parked nearby. He immediately ran to the 3000 lb unit and grasping the towbar attempted to steer it clear of the aircraft, but his initial efforts were thwarted by the ice-covered tarmac. Finally by using his body as leverage, he managed to bring about a slight change in course and the CSU came to rest against the aircraft pitot boom without causing damage.

Pte Doucet's alertness and quick thinking undoubtedly averted costly damage to the parked CF5.

Comments
to the editor

Rotorwash Questioned

Q. When is a question not an answer? A. Yes, when it appears in Rotorwash (Flight Comment, Nov-Dec 72, page 20). That is about how it read and I am still at a loss as to the point being made.

Even in 1972 I still believe in ground cushion – since there *IS* a "nice little bubble of air built up" under the aircraft which *DOES* help support the aircraft. This pressure build-up opposes the induced flow, thereby reducing it; therefore, the same angle of attack can be maintained with less pitch, hence less power.

This "ground cushion" is, in essence, augmented ground effect, and, as such is *not* really the same as a fixed wing aircraft's reaction (unless it happens to have one wing nailed down) to reduced up/downwash. A fair comparison might be a helicopter *translating* close to the ground (ie, in ground effect, without ground cushion).

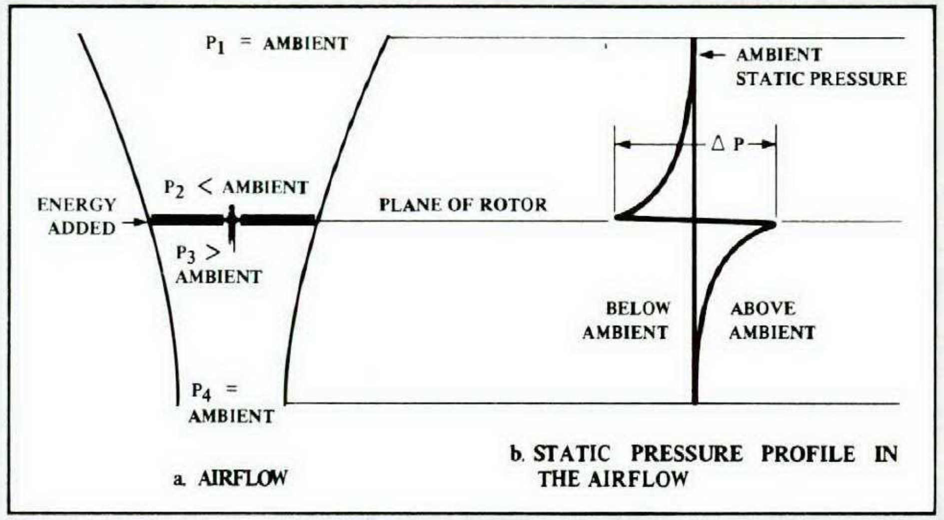
Captain W. Morris
TCHQ

We took a little poetic licence with the first "ROTORWASH" in order to draw people's attention to the introduction of a new series. The response indicates that this achieved some measure of success.

In your letter you indicated that there is a build up of pressure that not only helps support the aircraft but opposes the flow, making ground effect more effective.

In order to compress a gas it must be in a closed container and unfortunately the rotor system is not a closed container. As the air comes through the rotor system and hits the ground it moves outward as can be seen when hovering over a grassy surface.

The relationship between the pressures and velocities must be kept in mind. It is the static pressure that moves the air. The Δp across the rotor is the measure of energy added by the powered rotor. In the Diagram of the Rotor Static Pressure Pattern, Bernoulli's equation can be applied from Point 1 to Point 2 to explain why a negative pressure exists on top of the blades. Static pressure has decreased and dynamic pressure has increased from ambient because velocity increases. Then the rotor increases the static pressure by an amount, Δp giving a static pressure higher than ambient below the rotor blades. This, of course, agrees with the basic understanding of pressures existing on the rotor blade which is producing lift.



a. AIRFLOW

b. STATIC PRESSURE PROFILE IN THE AIRFLOW

Below the rotor we can again use the Bernoulli equation between Points 3 and 4. Again, velocity is increasing, so dynamic pressure increases and static pressure decreases until it returns to the ambient value. At that point maximum downwash velocity occurs.

Utilizing the relationship between force and pressure, we see that rotor lift is also equal to the change in pressure across the rotor times the rotor disc area.

A hovering helicopter moving forward will experience a slight loss of lift. This loss of lift is not due to the moving out of the ground effect unless it is accompanied by a simultaneous climb. The helicopter carries its ground effect with it.

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helicopter achieves some slight forward velocity the inflow through the rotor due to the forward speed will decrease the magnitude of the induced power which needs to be furnished by the engine. The helicopter will achieve effective translational lift and rise slightly.

CATCA '73

The Canadian Air Traffic Control Association will be holding their biennial convention in Winnipeg May 14 – 17, 1973. Further information may be obtained from the undersigned, at 370 Harcourt Street, Winnipeg, Manitoba, R3J 3H7.

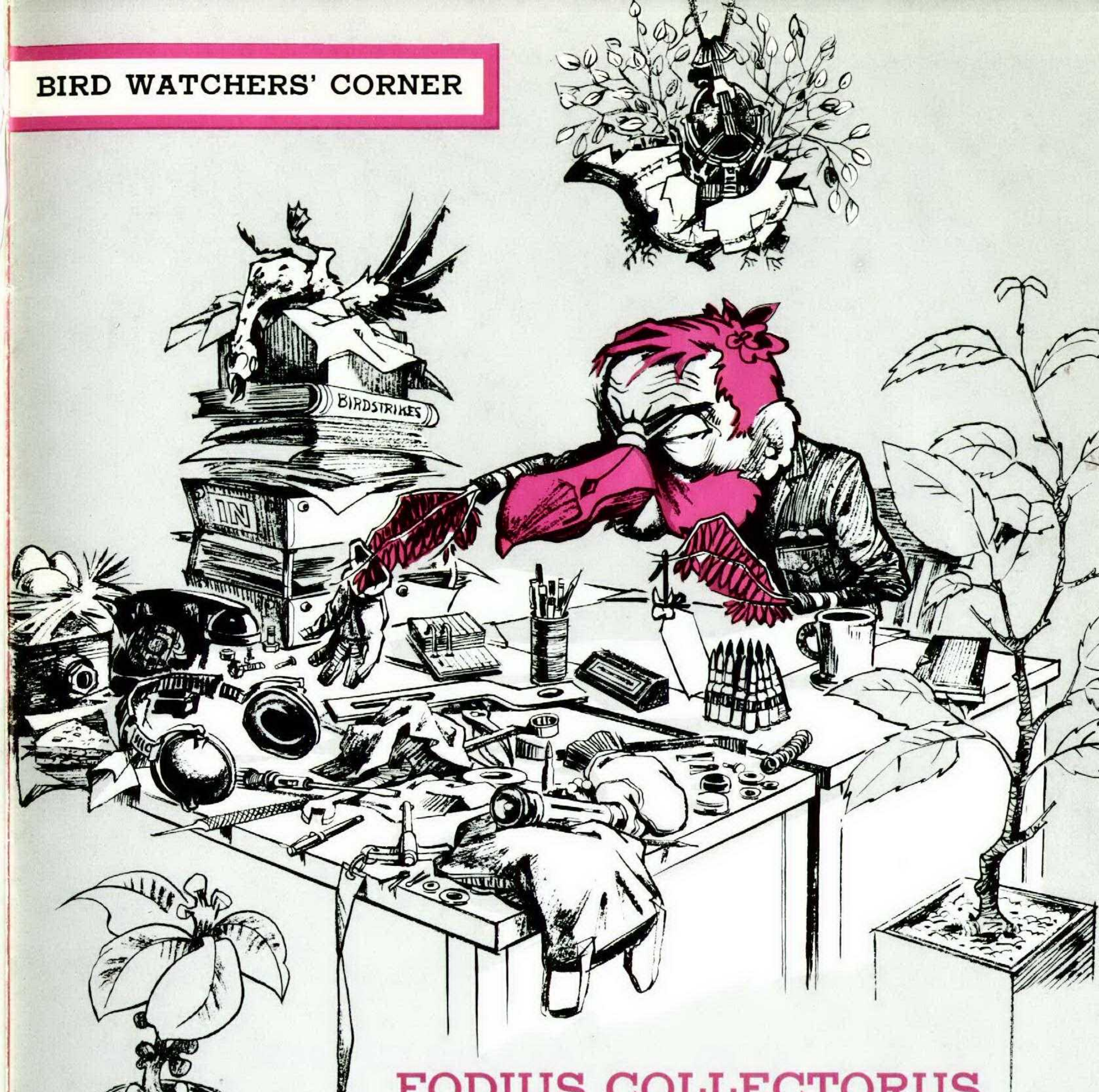
D.W. Stinson
Publications Chairman
CATCA '73

Trouble Shooting

The chairman stated that airborne trouble shooting should be conducted within the individual's capabilities only. He stressed that most trouble shooting is best done on the ground.

The Flight Safety Committee

BIRD WATCHERS' CORNER



FODIUS COLLECTORUS

A weird and wonderful clutter of odds and ends is a setting most favourable for attracting a Fodius Collectorus. Early in the year birdwatchers are treated to the sight of this avian hoarder performing a tallying ritual, compiling stats on hazardous debris retrieved from aircraft during the year just ended. The elusive purpose of his annual ritual is to eliminate lethal litter, which he attributes to lack of quality workmanship on the one hand, and on the other, failure to implement prevention through designs well within present capability. As he labours to create meaningful messages from the motley mess he occasionally emits a moanful call:

WE-MAY-GROUND-THE-WHOLE-FLEET UNLESS-WE'RE-MORE-NEAT

二見如百聞也

*Two pictures worth
a thousand words