AEROSPACE

SAFETY • MAGAZINE FOR AIRCREWS

NOVEMBER 1979

IN THIS ISSUE:

you vs hydroplaning... AND THE WINNER IS?

■ Take our little quiz and then check Slick Nick's comments and see how you did. The answers are at the end of the article. No peeking!!

1. (T or F) Hydroplaning is broadly defined as a condition of high coefficient of friction created between the tire and the runway surface.

2. Hydroplaning may be considered under three categories. Match the following appropriate items with the correct definitions below.

a. Dynamic c. Viscous e. Reverted Rubber
b. Hysteresis d. Hydrometer

I. ________ occurs only on runways that have a smooth surface texture or a runway surface made smooth by rubber deposits or paint.

II. ________ occurs when the tires are separated from the runway surface by water. The tire rides above the surface on a wedge or film of water and the fluid displacement drag eventually results in slowing and finally stopping rotation.

III. ________ heat generated by braking friction produces superheated steam at high pressure which is trapped in the tire footprint area. This causes the tire rubber to change back to its uncured state.

3. Under the three categories of hydroplaning there is one that is considered the worst because it can occur down to zero speed. Select one.

a. Viscous
b. Reverted rubber
c. Dynamic
d. Hysteresis
e. Hydrometeor

4. (T or F) There is no evidence that tire diameter directly affects the coefficient of friction available on wet or dry surfaces.

5. When anticipating a hydroplaning situation, without antiskid, braking technique is an important consideration. Select the most correct response.

a. Apply and maintain maximum brake pressure as soon as the aircraft touches down.

b. Use intermittent braking by applying a smooth moderate application followed by a short nonbraking period to cool the pads.

c. Apply a smooth and steady brake pressure trying to maximize braking forces without locking the wheel and causing a skid.

d. Refrain from using the brakes allowing the aircraft to roll out. If the aircraft has not stopped by the 1,000 ft remaining marker, stomp on the brakes and attempt to blow all the tires.

6. (T or F) In a total hydroplaning condition, an aircraft can be expected to depart the side of the runway at a rate equal to the existing crosswind component.

7. (T or F) When a tire is in a locked wheel skid it has no cornering force. Cornering force is necessary to maintain control of the aircraft on the ground.

8. The primary function of a tread pattern is to:

a. Improve cornering ability.
b. Give a smoother ride.
c. Increase the tire's service life.
d. Improve the tire's frictional properties on wet surfaces.

9. An aircraft that uses a deceleration chute as a braking device has the potential to amplify the hydroplaning problem under what conditions.

a. Wet runway with a strong tail wind.
b. Wet runway with blown tires.
c. Wet runway with a significant crosswind.
d. Wet runway with a suspect antiskid malfunction.

10. (T or F) If you are fortunate enough to have a state-of-the-art antiskid system or engines equipped with reverse thrusters, hydroplaning is no longer a serious concern.

Well, how did you do? Slick Nick says:

11-12 right One for the good guys, a TKO in the 10th, no doubt you know your stuff.
9-10 right Split decision, better read my article.
8 or less Check your wings and see if the back is stamped "dry runways only." Read my article and take notes!!

continued on page 2

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SPECIAL FEATURES

REGULAR FEATURES

DEPARTMENT OF THE AIR FORCE • THE INSPECTOR GENERAL, USAF

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Let's examine the three types of hydroplaning: dynamic, viscous and reverted rubber. I have provided an example of each type by taking actual cases from the mishap files. First, an example of dynamic hydroplaning.

The day is dark, cold, and rainy; miserable unless you're a duck. The crew arrives and does an exterior and interior checklist. The ground crew assures the aircrew the pretaxi checks are complete, and the aircrew taxis out to make an on-time takeoff.

As they are rolling down the runway, both pilots notice their airspeed indicators are stuck between 55-60 knots although aircraft acceleration and engine power appears to be normal. Guess what, gang? The pitot covers are still on!! Well, a little pride at stake, but no problem, all they have to do is get on the brakes, right? Wrong! Dynamic hydroplaning has reared its ugly head. The pilot retards the throttles to idle, raises the speed brakes, and applies full brakes but there is little, if any, effect. End result, the aircraft leaves the runway and comes to rest after traveling 300 ft on an unprepared surface.

Under total dynamic hydroplaning, water pressures between the tires and the runway lift the tires off the surface. Under such conditions, a nonrotating tire will not spin up after touchdown and a tire that was rotating will begin slowing and may stop. The coefficient of friction is reduced to near zero, making braking, cornering and steering ineffective.

Dynamic hydroplaning problems can be aggravated by crosswinds and drag chute deployments as illustrated in this recent mishap. An F-4 was making an approach in heavy rain and a crosswind. Touchdown was on centerline and the aircraft was tracking straight ahead. The pilot deployed the drag chute and the aircraft sharply swung to the right and began drifting toward the edge of the runway. The pilot, reacting quickly, effected full left flight control inputs, used differential thrust, and jettisoned the drag chute.

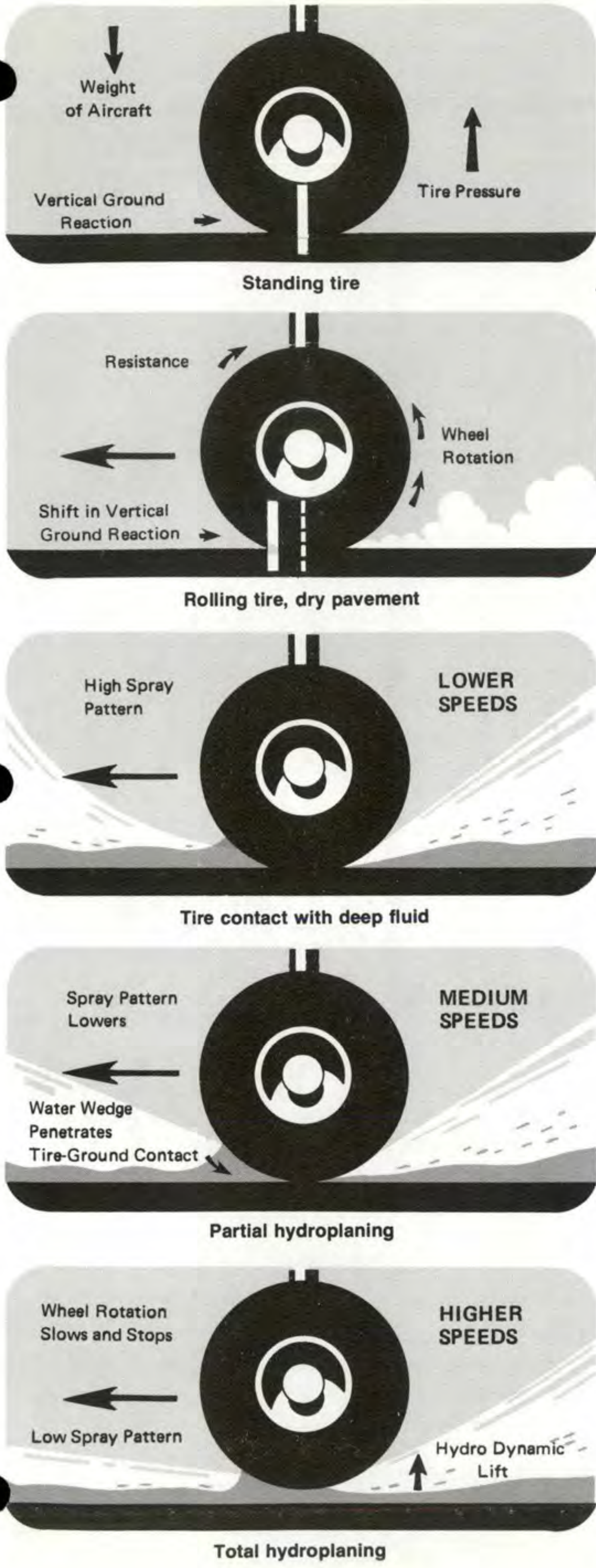
The aircraft's skid was stopped, the aircraft returned to the centerline and the remainder of the landing roll was uneventful. The pilot's quick analysis and timely action averted a major mishap caused by good ol' dynamic hydroplaning. Let's move on to viscous hydroplaning.

The mishap aircraft was scheduled for a single-ship instrument training mission. Approximately 20 minutes after takeoff, the pilot received a weather recall due to heavy rain approaching the base from the South. He returned to the base and made a normal landing just before a heavy rain shower reached the south end of the airfield. He turned off the runway, completed his checks, and then was cleared back on the runway (now inactive) to taxi to the parking ramp. By this time the heavy rain shower had reached midfield along with gusty winds. When the pilot attempted to turn off the runway and into the parking area, the aircraft began an uncontrollable skid. The aircraft departed the prepared surface, collapsed the right main gear, and damaged the wing and tail section.

Viscous hydroplaning occurs on runways that have smooth surface texture, significant rubber deposits or certain types of paint. A tire on these surfaces can only partially displace the trapped water film. Notice I'm saying film, it doesn't take much moisture, even a light dew can cause viscous hydroplaning given the right smooth runway surface. Recovery of tire braking and cornering ability is speed dependent so. . . . On slick runways or taxiways exercise caution and keep your speed down when attempting turns.

The last category of hydroplaning, but certainly not the least dangerous, is reverted rubber hydroplaning. In this particular case, the mishap aircraft started with dynamic hydroplaning and ended up with reverted rubber hydroplaning.

The aircraft touchdown was normal and in the first thousand feet. The pilot tested the brakes at approximately 110 KIAS. The brakes immediately locked up due to the wet, slick runway (dynamic hydroplaning). As the aircraft's speed decreased and the effects of dynamic hydroplaning were lessened, the tire began heating up due to the friction increase. Soon a layer of steam developed between the tire and the runway. The rubber reverted to its natural latex state and formed a seal to prevent water dispersal. The tire was riding on a bubble of superheated steam and molten latex.



Standing tire

Rolling tire, dry pavement

Tire contact with deep fluid

Partial hydroplaning

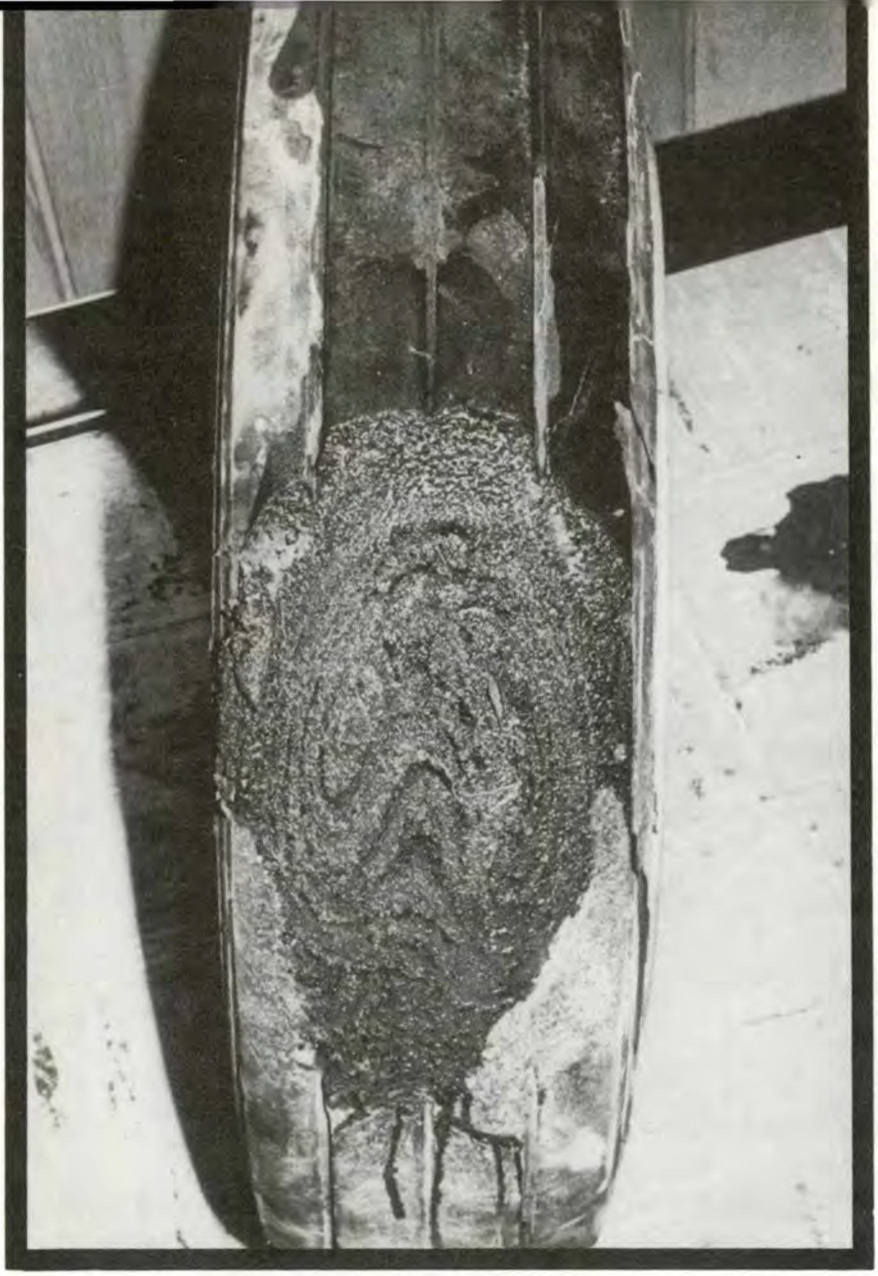
Total hydroplaning

The operational antiskid did not recognize the aircraft was in a skid and, therefore, did not provide any assistance. Even though the pilot attempted numerous techniques to regain control of the aircraft, it finally departed the runway causing aircraft and runway lighting damage.

As long as the wheels are locked, directional control is lost. The pilot has to get off the brakes, get the tires rotating once again and regain cornering ability. Then he can effectively use nose wheel steering and/or aerodynamic controls, plus he can use the brakes again to stop the aircraft. Reverted rubber hydroplaning is the most dangerous because it can occur down to zero speed.

Progress is being made on the problem. Such things as runway groving and cleaning, tire tread design, using paints that resist viscous hydroplaning, better antiskid systems, and aircrew education are lessening the hazard. You, the crew member, can enhance your chances in beating the big ''H'' by:

- Understanding the mechanics of hydroplaning.
- Reading and heeding your flight manual.
- Planning your landing or takeoff to avoid as many of the contributing factors of hydroplaning as possible. For example, if rain is present and dual runways are available, one is grooved and one is not, and either one is adequate considering your takeoff performance, select the grooved runway.
- Anticipate hydroplaning problems when landing or taking off on wet runways.
- While taxiing use extreme cau-



You've heard of reverted rubber hydroplaning. Here is how a tire looks after the tire has been riding on a bubble of superheated steam and molten latex.

tion. Slow, smooth turns are recommended.

▪ The best braking technique is to apply a smooth and steady pressure trying to maximize the braking forces without locking the wheels and inducing a skid. Braking research has found intermittent braking serves no useful purpose because the periods between brake application produces light or negligible cooling.

▪ In a potential hydroplaning situation, a firm landing is preferred over a grease job, since it will do a better job of getting the tires rolling on the paved surface rather than skidding on the water.

▪ Be aware of crosswind and its affect on hydroplaning. If you fly an aircraft using a drag chute, know the hazards associated with crosswind when dealing with wet runways and crosswinds.

▪ Know the limitations of your antiskid system when dealing with the three types of hydroplaning.

▪ Hangar talk with squadron IPs and Wing Stan Eval pilots. Get their impressions of the aircraft's susceptibility to hydroplaning and the best techniques to employ to recover the aircraft. ■

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Answers:

1. F
2. I.c.
   II.a
   III.e.
3. b
4. T
5. c
6. T
7. T
8. d
9. c
10. F

ICING--rethought

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Just because you do not see icing, it does not mean that you are not experiencing it.

■ Aircraft icing to most pilots is thought of in terms of clear, rime or frost and light, moderate or heavy. Most pilots must refer to the IFR Sup or *Weather for Aircrews* manual to spurt out accurate definitions of icing. One thing is certain however, pilots know you need visible moisture (clouds) and freezing temperatures to experience icing. Another thing pilots know is that the first place where ice usually starts forming is on the windscreen (or windshield wipers for heavy drivers), and this visual indication usually precedes cockpit ice warning lights.

Despite these commonly held beliefs, there is another form of icing not defined in the IFR Sup nor preceded by visibly detectable airframe icing. I am, of course, referring to inlet duct icing. Pay close attention to the following facts and be aware you do not have to think winter to experience this phenomenon.

NASA's Lewis Research Center reports that the conditions that produce turbine inlet icing are visible moisture from ground level to 15,000 feet and temperatures from -5 to -18°C. The exception to this is cumulonimbus clouds which can cause inlet icing as high as 40,000 feet. Engine and inlet icing builds up fast and can occur before an accretion of ice is visible on the aircraft surface. This situation is most likely at high engine rpm and low flight speeds associated with takeoff, penetration, and approach.

Also consider that maintenance specialists use an air temperature of less than 40 degrees F. and a temperature and dew point spread of less than 7 degrees as a guide not to run engines on the trim pad due to the possibility of ice formation. Therefore, the possibility for induction icing to occur below the freezing level does exist.

The situation presents itself during the fall and winter months during GCA patterns with an overcast and temperatures near freezing, even though the clouds may actually be below the freezing level. Another weather phenomenon which may provide conditions right for induction icing is heavy to moderate rain showers.

A T-38 cruising at 6,000 MSL with the freezing level reported between 10 - 12,000 feet experienced a dual engine flameout on landing from ice ingestion. The crew reported at no time entering what they thought were icing conditions (that is, temperature below freezing and seeing accretion of ice on the airframe); however, maintenance investigation revealed that engine damage and subsequent flameout was caused by icing.

Weathermen report that during heavy precipitation the OAT may be lowered as much as 10 degrees due to the cooling effect associated with the falling water. So, even though below the freezing level, conditions for icing may exist.

What is the danger associated with induction icing? First of all, the pilot isn't aware it is happening. Secondly, for non all-weather aircraft without anti-icing equipment the danger may be fatal depending on when the icing occurs.

Talon Service News, Oct-Nov 78, describes what the result of engine icing may be. "Ice particles dislodged from the air inlet duct lip and/or inlet guide vanes can cause foreign object damage. Ingestion of dislodged ice particles into an engine may be evidenced by increased vibration or unusual noise from the engine. Normally, this FOD will reduce the stall margin but not cause engine failure. However, be alert for a possible compressor stall, when increasing power. Engine instrument indications may remain normal, even though the inlet guide vanes and first stage compressor blades have been damaged.

A senior maintenance engine specialist says, "I've inspected over 1,000 engines with ice damage, and not a single one was written up for possible induction icing."

So, what tips can the pilot use? Obviously, don't forget or discount all you know about structural icing and the icing limitations for your aircraft. In addition, be aware of the conditions in which induction icing may occur. Be especially aware that the takeoff and approach phases of flight, with slow airspeed and high power setting, are conducive to induction icing when atmospheric conditions are proper. Don't forget that, just because you cannot see structural ice forming, you are safe. Try to remember the conditions under which induction icing may occur – it may save your life. ■

Loss Of Consciousness In High Performance Fighters

(What To Do About It)

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■ The problem is that our new generation fighters with their low wing loading, high thrust to weight ratios, and rapid G onset rates have exceeded the ability of the human body to withstand positive G loads. All crew members of high performance aircraft are familiar with such G-induced symptoms as grayout and blackout (loss of vision) which are caused by a significant reduction of blood flow to the head. A pilot will normally respond to these symptoms of excessive G loading by slightly relaxing the Gs so that he can maintain vision. However, if a crew member is subjected to a sufficiently high +G load, especially if it is of very rapid onset, the usual warning signs of grayout and blackout are bypassed and LOC can occur. Loss of consciousness is obviously extremely hazardous because situational awareness and physical control of the aircraft are completely lost. In addition, research on LOC in the human centrifuge has revealed two important and disconcerting facts:

1. Following a LOC there is a period of complete incapacitation.
2. The subject who experiences LOC does not remember the episode.

The incapacitation which follows a LOC averages 15 seconds and the possible consequences of such an event occurring at low altitude and high airspeed are obvious.

The amnesia which has been shown to occur on the centrifuge is important because it is possible that LOC could occur and the pilot not recall the episode. He might remember only a vague sensation of something being wrong. If he did find himself in an unusual attitude and not know how he arrived there, he might realize that something unusual had happened, but because of his fear of grounding, the episode might not be reported to his supervisor or flight surgeon. The combination of amnesia for the event and fear of grounding has probably caused an under-reporting of the actual number of LOC incidents.

We now come to the big question – does LOC occur in flight? The answer is YES. In the past two years there have been several cases, both documented and undocumented in which LOC has occurred in flight. The majority of cases have involved the F-15, but there have been other suspected episodes in the F-4, F-106, and even an OV-10! The typical episode occurred during ACM when the pilot suddenly acquired a target and initiated a hard turn. The next thing he knew he was in a nose low attitude and had no idea how he arrived there. In some of the episodes, the pilot later discovered that his G suit hose was not connected. Fortunately, the aircraft were recovered in all cases and no accidents are known to have occurred as a result of LOC in flight. But the potential for disaster is definitely there. In addition, a LOC in combat would make the aircraft a "duck" for approximately

15 seconds.

The obvious solution for LOC is to increase the ability of the pilot to withstand rapid onset, high G loading. This can be done through conditioning and training of the aircrews, and better life support equipment.

Because human G tolerance is dependent on many factors, a pilot can improve his G tolerances through several means:

1. Such things as proper rest, nutrition, and not flying when ill are obvious.

2. Because G tolerance is partially dependent on an adequate circulating blood volume, avoidance of dehydration is essential. Dehydration can be prevented by adequate intake of fluids and salt, avoidance of excessive alcohol and coffee intake, and a period of acclimatization when operating in a high temperature environment.

3. All aircrew members should receive periodic refresher training in the performance of a proper M-1 maneuver. Most pilots receive this training during UPT and subsequently receive little or no refresher training. Ideally, such training should be performed on a centrifuge because experienced fighter pilots who have received refresher training on a centrifuge have stated that the training did improve their G tolerance.

4. Exercise. Recent studies have shown that running does not significantly improve G tolerance but weight lifting, especially exercises designed to strengthen the abdomen, upper arms, and upper legs can increase G tolerance. Running or some other form of aerobic exercise should be continued as part of an exercise program because of its other beneficial effects.

5. Pilots should carefully ensure that their G suit hoses are properly connected and recheck them periodically during flight. In addition, pilots and life support personnel should ensure that the G suits fit properly and are readjusted if there is a weight gain or loss.

6. IPs and WSOs who fly in the back seat of fighters are especially vulnerable to LOC because they sometimes have no warning of high G loads. Therefore, they should be especially alert for such situations.

At the present time, life support equipment specialists and engineers are in various stages of evaluating and testing methods to improve G tolerance. Some of these are:

1. A High-Flow Ready pressure valve which provides for more rapid inflation of the G suit. This is currently being tested in F-15s.

2. Reclined ejection seats.

3. Design of a cockpit which provides elevation of the pilot's legs.

4. Positive pressure breathing.

Finally, a pilot can prevent LOC by flying his aircraft properly — make all control inputs smooth, be aware of your G level, and be alert for Mach tuck.

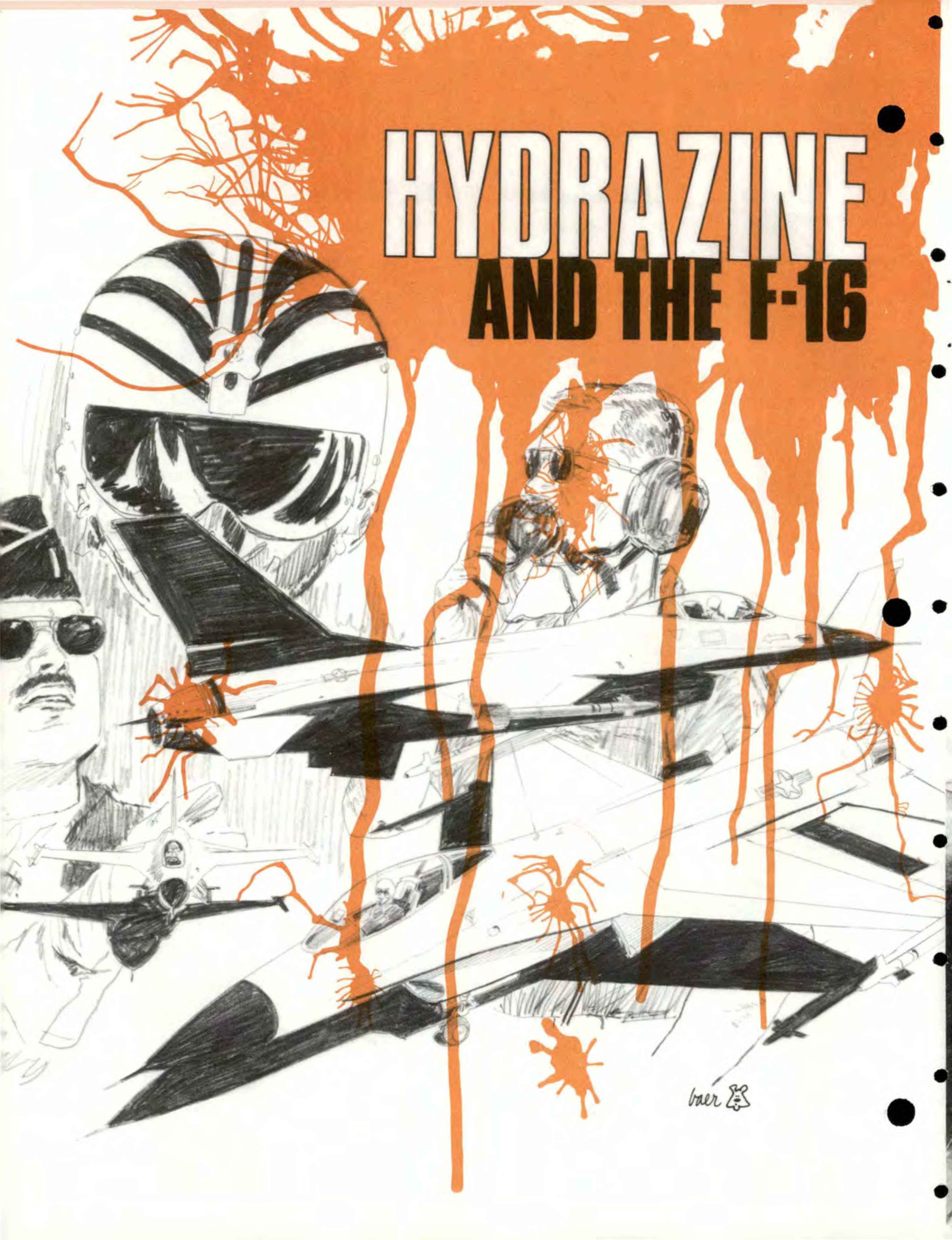
In summary, G induced LOC is a very real problem with the potential for disasterous consequences. But by proper training and awareness the problem can be avoided. The goal of increased G tolerance is not to make everyone capable of pulling 10 Gs all day long (maintenance already has enough problems with over Gs), but to increase a pilot's G tolerance so that he can withstand unexpected and rapid onset G loads. In addition, increased G tolerance will enable the fighter pilot to fight more comfortably, with less fatigue, and with better vision (you can't fight somebody you can't see).

Good luck and happy hunting. ■

ABOUT THE AUTHOR

Major Nash was severly injured in a combat mishap several years ago while serving as a pilot in the Air Force. He spent a year in the hospital and decided to become a doctor. Major Nash graduated from medical school, then reentered the Air Force. He has been reinstated as a pilot and is now flying the A-10.

HYDRAZINE AND THE F-16



MAJOR WARREN D. TUTTLE
USAF, Ret.

■ The use of hydrazine in the F-16 emergency power unit (EPU) has caused a lot of concern among those of us who may become exposed to the substance. True, it is a hazardous propellant and can cause severe harm to the old bod if prolonged exposure occurs. But let's face it, gang – as long as we know it's bad stuff we're not going to hang around and smell it – or are we? The guys and gals who work with the F-16 and its subsystems are well versed on the hazards of hydrazine – but what about the people at installations that may occasionally recover an F-16?

After a great deal of debate on numerous hypothetical scenarios, several facts soon become apparent:

- While probability of a hydrazine leak is very remote, it will occur eventually at some non-F-16 base.
- The impact, even under worst case situations, on personnel or property, will be minimal if a few simple precautions are exercised.
- The pilot must be thoroughly acquainted with the appropriate response if his plane springs a leak.

Rather than read a dry dialogue on the why, where, and what to do, test your basic common sense on the following situational questions. While each question is aimed at a specific duty position, knowing what those people should do certainly expands your smarts as well. Remember – the F-16 EPU contains 6.8 gallons of hydrazine mixed with water; the stuff is toxic when inhaled or absorbed through the skin; it has an odor like ammonia; and it can corrode materials (like aircraft components, maybe?).

Q. You, an installation commander (or airport manager), want to be properly prepared when, and if, an F-16 lands. You should

a. Develop an emergency F-16 response plan and practice it quarterly.

b. Instruct the supervisor of flying to close the runway if there is an F-16 in the area.

c. Tell your recovery crews to treat the F-16 like any other aircraft unless the EPU has been fired and, in that case, listen to the pilot when in doubt.

d. Procure the necessary equipment to cope with a potential hydrazine spill at your base.

A: The best approach is answer c. While a response plan may be a slick idea, a hydrazine spill is not different from any other hazardous chemical spill, and these plans should have already been formulated. If you have access to household bleach (the grocery store), clean rags (linen supply), a self-contained breathing device (the fire department), rubber gloves (the grocery store again), and several big plastic garbage cans (back to the grocery store), you have all the equipment you need. The probability of a hydrazine leak occurring when the EPU has not first been fired is so remote that it need not be considered here.

Q: You, an F-16 pilot, are doing your thing when the EPU activates. You should

a. Go to 100% oxygen immediately.

b. Give the old Omega Sierra mumble, level the wings, and punch.

c. Land immediately at an airdrome with an adequate runway.

d. Evaluate the situation and decide whether to land immediately or press on to an F-16 base.

A: This is kind of a toss-up between c and d. The other two answers just won't cut it. If there is any doubt as to the sustained airworthiness of the ship, don't search for an F-16 base; get it on the ground.

Q: You, an F-16 mechanic, are removing the hydrazine cylinder after the EPU has fired when a couple of drops of hydrazine bubble out of the quick disconnect. You should

a. Declare a hydrazine spill, clear the area, and notify the base bioenvironmental engineer.

b. Check to see if anyone was looking and wipe the hydrazine up with a clean rag.

c. Forget it.

d. Spray the EPU compartment with a bleach decontaminating solution.

A: The best response is b. Release of a couple of drops of hydrazine is expected when the quick disconnect is uncoupled; therefore, it is not considered a leak. The reason you would look to see if anyone was watching is because you forgot to place the clean rag under the disconnect before you pulled the lines apart. After wiping off the hydrazine you should thoroughly clean those areas contacting the hydrazine with water.

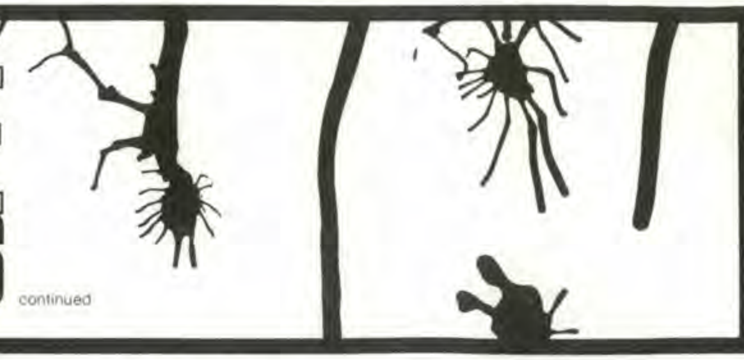
Q: You, a transient alert crew member, have just parked an F-16 which had an in-flight EPU firing and notice some clear fluid dripping from the fuselage onto the ramp. The first thing you should do is

a. Advise the pilot, then clear the area.

b. Confirm the substance by giving it the old taste test.

HYDRAZINE AND THE F-16

continued



c. Put a clean drip pan under the leak.

d. Instruct Airman Jones to plug the leak with his finger until help arrives.

A: While it would be wise to use a drip pan to contain the leak, the best maneuver at this point is answer a. We don't expect transient alert people to be completely proficient in hydrazine procedures. The most accessible individual who will be up to date on these matters will be the pilot. He should be the authority to advise on the best way to contain any leak that may evolve.

Q: You, an F-16 pilot, have recovered your aircraft at a strange base following an in-flight generator failure. The ground crew advises that you are dripping some stuff all over the runway. You should

a. Tell the ground crew to get the fire department to hose down the ramp.

b. Confirm the fluid is hydrazine by using your handy dandy litmus paper (readily available from the aircraft forms).

c. Top off and split.

d. Check the bold print instructions in the Dash 1.

A: The first thing to do is to be sure the leak is actually hydrazine. This can be done as stated in answer b. Believe it or not, we are trying to get litmus paper strips in the F-16 aircraft forms. In leaks we have experienced in the past, small drips of hydrazine usually accumulate around the drain port of the EPU compartment. By simply rubbing the litmus paper around the port, the pilot can readily confirm or rule out a leak.

Q: An F-16 with an activated EPU lands at your base when you are on transient alert duty. You, the transient alert troop, smell an ammonia odor and notice some fluid dripping from the EPU compartment. You should

a. Tell the pilot and immediately seek medical assistance.

b. Lie down so you won't hurt yourself when you drop dead because you have had it, buddy.

c. Advise the pilot and clear the area.

d. Locate the nearest emergency shower.

A: While hydrazine is a very hazardous substance at high concentrations or when exposure to low concentrations occurs over long periods of time, neither of these situations should occur when an F-16 EPU develops a leak. The only time we would recommend medical attention is if the fluid is actually splashed on the exposed skin; and if that occurs, the first order of business is to wash it thoroughly with copious amounts of water. If you smell the hydrazine, the best thing to do is answer c.

Q: You, the installation commander, have been told by the pilot that his EPU has a confirmed hydrazine leak. You should

a. Mobilize your disaster response force for chemical spills.

b. Request your bio guy (if you have one) assist the pilot in assessing the situation.

c. Request the fire department provide self-contained breathing devices in case they are needed by people containing the spill.

d. All of the above.

A: Since no AF quiz is complete without at least one answer being "all of the above," this is a good place for it. A really concise plan to cope with these events is nice but may be unworkable. The best pursuit is to know the concept and be flexible.

The disaster response force will have the people to contain the leak. This will be done under the direction of the pilot or other competent authority. The bioenvironmental engineer will be extremely valuable in determining the extent of the release and advising on environmental concerns.

The people performing the containment may require respiratory protection and impervious gloves depending on the magnitude of the hazard. After the leak is contained, the next step is to advise the home base to come and clean up their mess.

While the above questions may not cover all the requirements when a hydrazine incident occurs at a non-F-16 base, they touch on most of them. ■

FLYING 'MAPLE FLAG'

By **DAVID HEALY** (HQSTC Public Relations)

USAF crews have been receiving realistic training in such exercises as *Red Flag* on the Nevada desert. Some have been receiving different experience over the snow, ice and forests of Canada in Exercise Maple Flag. This article tells about it.

■ A hundred and fifty feet above the treetops, the crew of an RAF Buccaneer spotted a pair of moose wandering through the Canadian silver birch forest – and at 450 knots, it was no more than a fleeting glimpse. But the pilot and navigator were not particularly interested in the flora and fauna of the Alberta countryside at that moment; they were more concerned with avoiding the predatory F-15 Eagle and F-4 Phantom fighters which they knew were in the vicinity – and with trying to miss the missile and antiaircraft artillery sites that dotted the terrain with heart-jolting frequency.

Eight Buccaneers from Strike Command's No. 208 Squadron were taking part in Exercise Maple Flag Three, being detached for that purpose to the Canadian Forces Base at Cold Lake, Alberta. The aircraft returned to their base at Honington, in May. Most of the aircrew and groundcrew involved were selected from 208, but some aircrew taking part from No 15 and 16 Squadrons from RAF Germany.

Maple Flag Three follows two earlier experimental exercises run from Cold Lake, and is the first of a series of realistic combat training exercises designed to run at a rate of two a year. An offshoot of the well-publicized *Red Flag* series held in the United States, *Maple Flag* is in fact largely American in its operation. Although the Cold Lake Base Commander is in control, personnel from the *Red Flag* staff at Nellis Air Force Base, Nevada, provide the exercise planning and the inputs.

Apart from the RAF Buccaneers, a wide variety of aircraft were taking part. The American contingent consisted of 35 aircraft from the USAF and the US Navy, including F-15 Eagles, F-4 Phantoms, F-5E Tigers, Starlifters and helicopters – which doesn't include the B-52s, FB-111s, E-3A Sentry aircraft and KC-135 tankers operated from their own bases in the States. The Canadians provided 24 aircraft, with CF-104s, CF-5s, CF-101s and various helicopters. Also taking part were their CF-100 and Falcon electronic warfare aircraft.

Red Flag and its offspring developed from the Americans' discovery that the first ten combat missions were by far the most hazardous for an aircrew. After completing those, the chances look much healthier from a life insurance point of view. In American terms, the "survivability rate" increases. The solution to the problem was to provide realistic

training which would simulate combat conditions.

With the "Flag" exercises, the idea is to make the course as realistic as possible for the participants, giving aircrew the chance to learn how to deal with threats from the ground and from the air – and how to get through to their targets. Imagination and initiative are encouraged, but a balance has to be struck with the need for safe flying. Areas such as the Nevada desert and the forest and muskeg of Canada pose less of a problem for military flying than in densely-populated Europe, but it is still, after all, a peace time situation: in war, aircraft would fly lower and faster.

CFB Cold Lake is a relatively new base, dating from the 50's, and has modern hangars and facilities. Its two parallel main runways, served by extensive concrete hardstandings, are rarely out of use during the daytime – Cold Lake is the largest fighter base in Canada. Dubbed "The home of fighter weapons," it is the base for 417 Tactical Fighter/Operational Training Squadron with CF-104s, and 419 Tactical Fighter/Training Squadron and 434 Tactical Fighter Squadron with CF-5s.

The Cold Lake Air Weapons Range, situated north of the base, is about 100 miles long by 40 miles wide. As the Buccaneer crews found out on their first acquaint flights, it consists largely of silver birch forests, lakes – many of them still frozen in June – and very little in the way of hills. One pilot commented: "It's like East Anglia – only flatter." The lack of hills causes some problems for low-level flyers who normally aim to keep below the hills, and calls for a different kind of skill. A camouflaged Buccaneer, for example, is not difficult to spot if it flies over the middle of a large, frozen lake.

Dotted through the range are targets and threat sites, with dummy tanks in clearings and a simulated airfield hacked from the forest with derelict aircraft strategically parked.

One of the immediate differences from *Red Flag* which aircrews notice is the difficulty of locating camouflaged sites amongst the trees and foliage compared with the arid desert and mountains of Nevada. At the moment, the majority of the Cold Lake targets do not have scoring facilities or much of the sophisticated electronics associated with Red Flag. USAF helicopters flew in some electronic threat simulators for this exercise, but changes are planned which should dramatically improve the facilities up to Nellis AFB standards.

Weather conditions at Cold Lake are favorable most of the year, despite the intense cold which freezes the lakes and rivers to a great depth – some of them solid. Even in late April, Cold Lake itself had three feet of ice, enabling local fishermen to drive out to their favorite spots by truck before cutting a hole for Eskimo-style angling.

Alberta's fortunate discovery of vast quantities of oil beneath its sparsely-populated surface has caused some problems for the Ca-

nadian Forces with the Cold Lake range. Some areas have been opened up for oil extraction, and that means that aircraft have to try to avoid manned sites. The Canadian Forces authorities have agreed not to release projectiles within six miles of manned sites, and within one mile of unmanned sites.

As in *Red Flag*, the exercise starts with a "composite" strike mission which involves large numbers of aircraft on sorties that include interdiction, recce, combat air patrol, escort, and suppression of electronic warfare threats.

The attackers, with their CAP cover, form the "Blue" forces, while their adversaries are "Red." From mission to mission, aircraft are switched from one side to the other, which calls for a high degree of flexibility. In addition, exercise inputs include the sudden changing of plans in the middle of a sortie – such as the changing of a target.

"Aggressor" squadrons of fighters use eastern-bloc tactics to break up the attacks; it is interesting to see some Canadian CF-5s sporting similar Soviet-style camouflage to their USAF counterparts in F-5E Tigers.

Search and rescue missions are also flown during the exercises to rescue "downed" flyers from earlier sorties; these unfortunates are selected from those deemed to have been shot down and are flown out to the range to be picked up later, hopefully, by fighter-escorted SAR helicopters. (One Buccaneer pilot imagined having to describe his surroundings to a would-be rescuer by radio: "I'm in a birch forest. . . .")

The benefits of *Maple Flag* vary according to the participants. For the Canadians, it gives them a chance to exercise with allied air forces, and to deal with realistic SAM and "triple-A" (antiaircraft artillery) threats. They expect their pilots will take part in *Maple Flag* at least once in each tour. For the others, *Maple Flag* simulates European geographic and climatic conditions far more than Nevada – although weather conditions are usually much clearer than on the Continent. (The Cold Lake base can be seen from the air at a range of 50 miles, according to the aircrew.)

But one of the biggest spin-offs for everyone is the chance for the airmen to learn from each other's tactics, strengths and weaknesses – and to develop their own ideas accordingly. The large ramps at CFB Cold Lake enable them to continue the liaison at ground level, with many of the aircraft parked in the same area, and social contacts and sports are encouraged.

(And those moose which inhabit the range? The Buccaneer crew which spotted two of them just had time to notice that the big animals ignored their sudden low-level appearance. Curious, they asked a Canadian pilot in the Mess why this should be. He explained: "I'm not surprised. They're all probably used to us by now!") – Courtesy July 1979 *Air Clues*. ■

4 BLUE NEWSLETTER

it's always THE OTHER GUY

■ Safety campaigns ought to be effective. Our basic motivation for survival and self-interest should be powerful forces in promoting safety. But safety propaganda will never be 100 per cent effective in achieving improvements because we all believe accidents happen to someone else, not to ourselves. The person reading the safety poster has probably not suffered the type of accident described, and probably believes himself to be too skilled to make such an error.

Don't give up yet – where the effort has been made to overcome dangerous conditions, the pattern of accidents has changed. Understanding of human factors has progressed sufficiently to be of real value in the design of our working environment. If adequate priority and emphasis is placed on reducing human error, there is no doubt that the goal can be achieved.

Commanders, flight leaders, and IPs all play an important role in developing a new pilot's flying ability and his respect for the aircraft performance envelope. It all begins with leadership and in a word – attitude. If our attitude is mission and safety oriented, others will see it and imitate it. If our attitude and resulting actions reflect self-discipline, concern for education, knowledge and respect for limitations, the less experienced pilots who follow us will think and act the same way. Attitude is contagious.

Commanders, flight leaders and IPs all play an important role in developing a new pilot's flying ability and his respect for the aircraft performance envelope.

We have come a long way since World War I. When aviation was in its infancy the Royal Flying Corps lost 2% at the hands of the enemy, 8% because of mechanical or structural failures of their aircraft and 90% as a direct result of their own individual deficiencies. The primary role in the modern man/machine system is a processor of information as opposed to the once essential role as a source of mechanical power.

We do not have a clear understanding of the factors which cause even well-trained, professional pilots to become involved in errors at critical points in flight. Neither do we understand the factors which may be responsible for their failure, to recognize and react to presumably clear warnings.

Let's have a look at a typical month. We will see that it doesn't always happen to the other guy. We have mishaps from T-37s, to RC-135s and A-10s to F-16s.

■ An F-4 was lead of a two-ship flight engaged in scheduled DACT (Dissimilar Air Combat Tactics) with two F-15s. After the third engagement, the F-4 started a climb and the stick went full left. The crew ejected successfully when they were unable to control the aircraft.

■ A C-135 pilot initiated a rolling takeoff on a wet runway. During power application, directional control was lost and an abort attempted. During the abort, the pilot failed to retard number four throttle and the aircraft made an accelerated left turn departing the side of the runway.

■ A fighter returning from a training mission flamed out due to fuel starvation. The pilot failed to reposition the air refueling switch after refueling. As the pilot experienced what he thought was sluggish control response, he made the decision to eject. In effect, reduced airspeed and an increased angle of attack produced the perceived sluggish flight control response.

■ An F-4E ended up in a nose-low spiral during the first engagement of a three-ship ACT (Air Combat Tactics) mission. During the recovery, the pilot heard two bangs as the throttles were advanced. The pilot ejected when the aircraft failed to respond to aft stick.

■ An A-10 rolled to about 80 degrees bank with the nose 10 to 15 degrees low following a dry air-to-ground missile attack. The chase pilot called for the pilot to roll out; however, the aircraft impacted the ground with no apparent attempt to recover or eject.

■ A trainer landed short of the overrun, caught fire and was destroyed following a straight-in no-flap approach. The IP allowed the student to fly a steeper than normal glide path which resulted in a high rate of descent at low altitude with power at idle.

■ Two F-4s were a free fighter and engaged fighter on a three-ship 2 vs 1 ACT mission. When the engaged fighter became stagnated, the free fighter began repositioning in the vertical and hit the engaged fighter. The free fighter misidentified the target aircraft as being the engaged fighter, then failed to make a "loss tally" call and proceeded into the fight regardless.

■ An F-4 touched down short of the runway threshold following a night single ship landing from a GCA. The right gear collapsed, and the aircraft departed the runway.

■ And finally, a T-38 on a student cross-country; the pilots ejected after interpreting a Stability Augmentor System malfunction as an aileron disconnect problem. This fixation followed from the crew's detailed knowledge of a previous T-38 fatal mishap involving aileron disconnect. The impression of flight control problems was enhanced by the increased stick forces – both pilots were on the controls due to a misunderstanding in transfer of aircraft control.

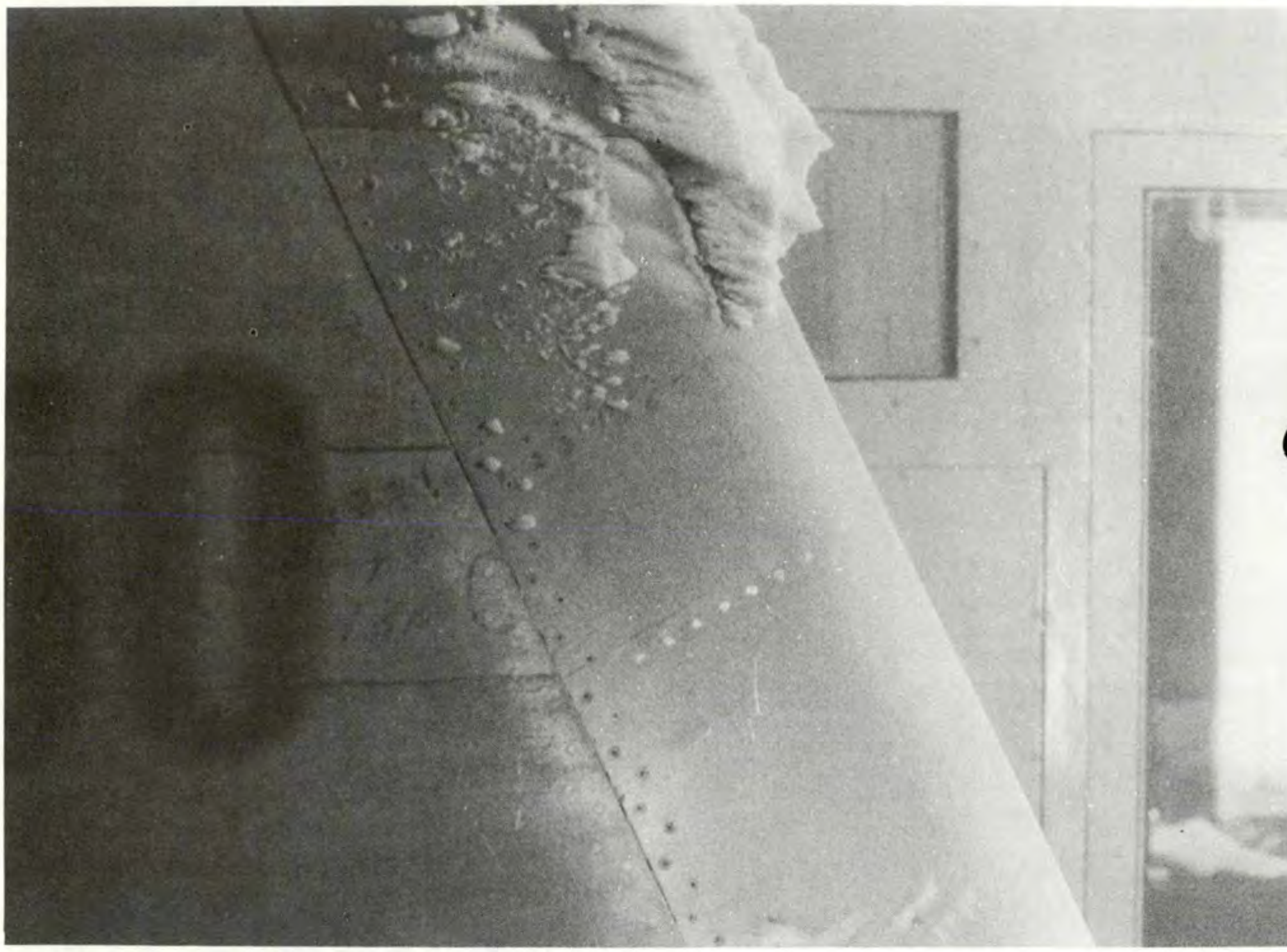
The lessons learned from this mishap, so very well expressed by the board, have significance for us all. The importance of thorough troubleshooting of aircraft emergencies when time and conditions permit. The board also notes caution should be exercised in digesting these lessons learned in their proper context. *The board believes delayed ejection during out-of-control conditions is a significant hazard to aircrew which must remain a pre-eminent consideration.*

Unfortunately, the best laid plans of mice, men and women sometimes go asunder. Most of us can't get the job done flying the thing like an airliner – they design fighters to perform, and we operate our aircraft fairly close to the limits. Close enough, in fact, that we occasionally find ourselves experiencing the first stages of control problems and have to back off to keep it in rein. We can say "stay within the envelope" all day long and we can preach fly safe 'til we are blue in the face, but until we realize the next accident they see in the papers may be ours, . . . we always believe it will happen to the other guy. ■

. . . until we realize the next accident they see in the papers may be ours, . . . we always believe it will happen to the other guy.

Wing Surface Roughness cause & effect

By **RALPH E. BRUMBY,** Principal Engineer, Aerodynamics



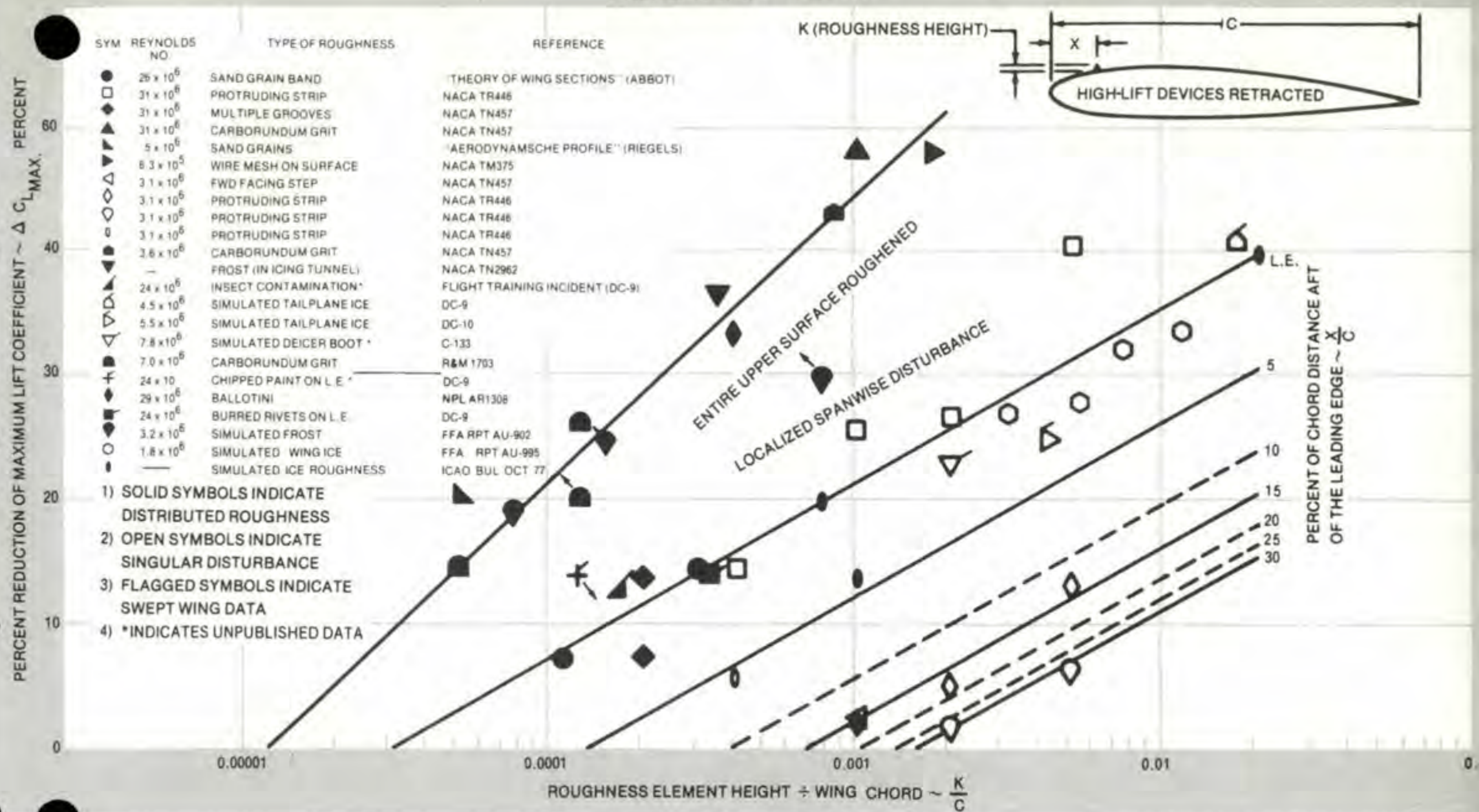
Wing section in icing tunnel—The amount of ice on the upper wing section generally means bad news, but the much lesser amount on the lower portion can also cause problems.

■ Most flight crew members are aware of the highly adverse aerodynamic effects of large amounts of wing surface roughness, such as the irregular shapes that can form on the leading edge during an icing encounter. However, what is not so popularly known is that seemingly insignificant amounts of wing surface roughness can also degrade flight characteristics . . . roughness caused by frost, snow or freezing fog adhering to the wing surface, large accumulations of insect debris, badly chipped paint, or a distribution of "burred" rivets over the wing surface.

In some countries, regulations do not permit takeoff when frost, snow, or ice is adhering to the aircraft. Elsewhere, however, dispatch is permitted if, in the judgment of the flight crew, the accumulation will not affect the safety of flight. Thus, a flight

Figure 1

REDUCTION OF MAXIMUM LIFT COEFFICIENT DUE TO WING SURFACE ROUGHNESS
HIGH-LIFT DEVICES RETRACTED



crew may be called upon to decide if a particular amount of roughness and its location are sufficient to significantly degrade the aircraft's flight characteristics.

The intent of this article is to assist in that decision-making by providing an insight into the effects of small amounts of wing surface roughness on aircraft flight performance.

For full wing span upper surface roughness beginning at the leading edge and extending varying distances aft, the typical effects are a reduction of the maximum lift coefficient (increase in stall speed), a reduction in the angle of attack at which stall occurs, and a rapid post-stall drag increase. The effects become more adverse as the size and chordwise extent of the roughness increase. They may also be accompanied by a reduction in lift at a given angle of attack and by an increase in the wing parasite drag.

Figure 1 is a correlation of wind tunnel and flight data showing the effects of surface roughness on the maximum lift coefficient of a wing with high-lift devices retracted. The effects of various forms of wing surface roughness differ when high-lift devices are used.

Typically, the deflection of trailing edge flaps tends to increase the effects shown. Full-span leading-edge high-lift devices tend to suppress the adverse effects of small levels of roughness, but have little influence over large levels of roughness.

Further complicating the overall situation is that premature stall due to surface roughness effects occurs at a lower than normal angle of attack. Therefore, it is possible that angle of attack-dependent stall warning system such as the alpha (*a*) vanes used on most current jet transports may not provide warning prior to actual stall.

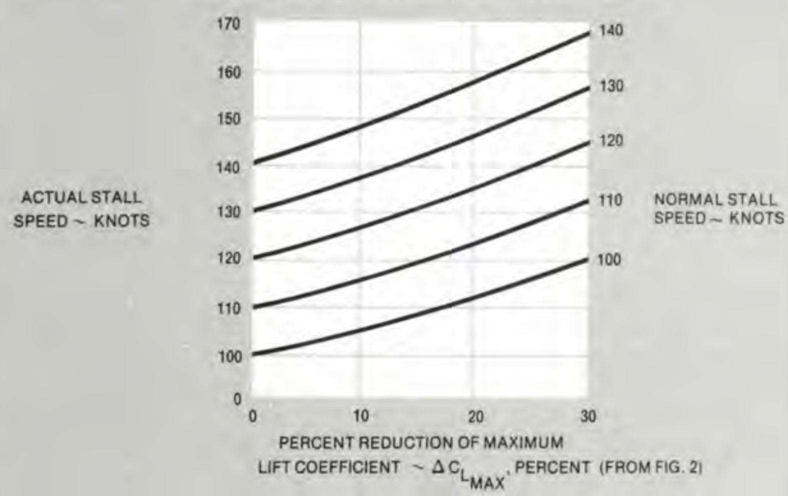
As might be expected, the leading edge portion of the wing is most sensitive to surface roughness. The effects of surface roughness on the maximum lift coefficient decrease as the forward-most extent of the upper surface roughness moves farther and farther aft of the leading edge. Also once slightly aft of the leading edge, moderate amounts of roughness on the lower surface have little or no effect on stall speed.

Most aircraft are designed for the stall to begin inboard in order to maintain lateral control as long as possible, and to achieve satisfactory pitching characteristics throughout the stall. Therefore, roughness extending less than full span may have a lessened effect depending on its location with respect to where the smooth wing stall initiates. Unsymmetrical roughness accumulation may result in premature stall of one wing, with resultant wing drop or rolloff.

What all this boils down to is that an aircraft affected by wing surface roughness will stall prematurely, possibly before reaching the angle of attack for stall warning actuation. Further, any reduction in lift at a given angle of attack will obviously

Figure 2

STALL SPEED INCREASE DUE TO A REDUCTION OF MAXIMUM LIFT COEFFICIENT



require a higher than normal airplane angle of attack to produce the desired amount of lift. This could, for example, require rotation to a higher than normal takeoff pitch attitude in order to achieve a normal liftoff and climb. Unfortunately, the higher angle of attack further reduces the already degraded margin to stall.

These effects are particularly important for early transport aircraft having no leading edge high-lift devices. Extension of the wing leading edge devices of more advanced aircraft will generally recover most of the stall speed degradation resulting from the low levels of roughness cited here.

The effects of small amounts of wing surface roughness may not be particularly noticeable to a flight crew operating within the normal flight envelope. Since all transport aircraft operating speeds have some margin above the actual smooth wing stall speeds, the roughness effects may have only decreased that margin. For example a 1.3 Vs approach speed may have had the margin reduced to 1.1 Vs, leaving little actual stall margin for maneuvering or gust tolerance.

In a recent accident, a flight crew decided that because they had experienced no problems during approach and landing through a mild icing encounter, they would dispatch without removing a small amount of ice that had accumulated on the leading edges During takeoff where the margin to stall is typically less than that for landing, the aircraft apparently stalled upon leaving ground effect and impacted at the end of the runway. This is not the only known incident. Frost appears to have been a contributing factor in at least two other recent takeoff accidents of transport aircraft.

Decisions to take off with some frost or snow on the wings may have been influenced by discussions of tests on military aircraft showing that frost appeared to cause no degradation in takeoff performance. But the tests were directed only at establishing if the particular aircraft would take off at the handbook speeds. No attempt was made to determine how much the stall margin had been reduced by the frost.

How rough is rough? Distributed roughness elements having a height of only 1/10,000 of the wing chord can adversely affect the maximum lift co-efficient significantly increasing the stall speeds as shown in Figure 2. This height corresponds to about 0.015 inch on a DC-9 type aircraft and to about 0.030 inch on a DC-8 or DC-10 type aircraft – about the roughness of medium to coarse sandpaper.

How does this compare with the roughness due to frost? Literature on frost indicates a seeming threshold where individual frost grains appear on a surface and are much like fine salt grains having effective diameters of about 0.004 inch. As frost progresses, the grains grow to about 0.010 to 0.015 inch in effective diameter. Further progression is usually of two forms: The layering of frost grains and the development of frost needles.

The layering can develop into an irregular surface of hills and valleys composed of numerous 0.010- to 0.015- inch grains — much like ripples in desert sand. In this case, the height of the irregularities will be more important than the individual grain sizes. The needles are usually closely spaced and have been observed up to 0.100 to 0.125 inch high. However, they are generally frail and have been known to break off to some lesser height at speeds of about 40 to 60 mph.

Observed on rare occasions is the development of "vertical frost-plates." Such plates can present extreme roughness as they are strong thin, vertical surfaces that have been observed from 0.125 inch to 0.250 inch high and 0.250 inch to 0.500 inch long at the base. They look much like closely grouped miniature vortex generators.

Crew members who have tried to brush off accumulations of frost (or snow) are also familiar with the rough surface that can form if the underlayers of an accumulation had melted slightly and then refrozen to the surface.

An operational problem occasionally encountered is the instance of an aircraft landing in a humid area after having been cold-soaked during high altitude cruise. During the ground time, the fuel in the tanks remains at a below freezing temperature, causing frost to form on the underside of the wing in the region of the fuel tank. Keeping that area frost-free becomes an almost impossible task. As the frost is removed it re-forms and will continue to form until the fuel temperature and the ambient temperature spread is more in line. While moderate accumulation will not affect stall, the surface roughness will increase the wing parasite drag and can affect takeoff performance.

All forms of roughness tend to degrade the lifting capabilities of a wing; therefore, other sources of small distributed roughness should not be overlooked.

Observations have taught us that stall speeds in the cruise configuration can be increased significantly due to chipped paint, "burred" rivets (i.e., flush head rivets along the wing leading edge whose edges have curled up) and the buildup of impacted insects on the leading edges.

One known experience with insects relates to a training mission of a particular aircraft. At 15,000 feet in the clean configuration, the crew prepared for a series of stalls. The calculated stick-shaker speed was 136 knots with stall at 131. At 140 knots, and without any warning, the aircraft went into a stall with a rapid roll to the left. During the recovery, the stick shaker activated and the stall warning came on. After recovery, a second stall was attempted, with identical results. A third stall with flaps at 15 degrees and slats extended, and a fourth stall in the landing configuration, also with slats extended, were executed and the aircraft behaved normally.

After landing, an inspection of the aircraft revealed heavy insect accumulation on the nose section and along the wing's leading edge.

The following day, after a thorough washdown, the same aircraft was flown again through the same stall series, under the same conditions. This time the aircraft performed on the numbers according to the book.

It is interesting to note the stalls that resulted, not only from insect accumulation, but from the "burred" rivets and chipped pant, were also abrupt and without prior warning. Available data from several occurrences are included in the correlations of Figure 1.

In recapping the details of this article, the following appear to be the most pertinent:

- Accumulations equivalent to medium or coarse sandpaper covering the full span of the wing's leading edge can cause a significant increase in stall speeds, leading to the possibility of a stall prior to the activation of stall warning.
- Wing leading edge high-lift devices, even in the extended position, will provide little or no benefit in recovering degraded lift due to large amounts of roughness. They will, however, recover most of the degraded lift caused by small amounts of roughness.
- Unsymmetrical roughness can cause wing drop, or rolloff, at stall.
- Moderate roughness present aft of the leading edge, a distance of about 10 or 15 percent of the wing chord length, will have little or no effect on stall.
- Roughness occurring slightly aft of the leading edge on the wing's lower surface will have little effect on stall, but it does increase parasite drag which will affect takeoff performance. ■

— Adapted from DC Flight Approach, McDonnell Douglas Corp.

eject or die

CAPTAIN S. R. VAUGHAN
355 TFS
Myrtle Beach AFB, SC

■ Pretty strong words, huh? But all too often the decision to eject is either not made or is made too late. Why? Many times this decision is supposed to be made for you long before the emergency situations arise.

How many times have we read or been told: "Out of control below 10,000 ft AGL – EJECT?"

But why do accident reports still contain such statements as "The crew died on impact," or "Ejection was initiated out of the safe ejection envelope, and the pilot received fatal injuries."

A recent aircraft accident involving a fighter in an out-of-control situation resulted in the death of two crew members. Some facts surrounding the mishap are known, some will never be known.

The aircraft departed controlled flight at approximately 12,000 ft AGL. The instructor pilot in the front seat deployed the drag chute in an attempt to recover the aircraft. The instructor pilot in the rear seat initiated a dual-sequenced ejection at a low altitude. The back seater's chute deployed seconds before collapsing into the water. The front cockpit ejection seat did not have time to leave the aircraft.

Why was the decision to eject delayed? We'll never know.

In 1978, 30 active TAC and TAC-gained aircrew members were lost in 52 Class A accidents. Many of these men would be alive today if a timely decision to eject had been made.

Let's look at a few cases where crew members did survive.

A pilot lost an engine on his twin engine aircraft. With the flight lead flying chase, he returned to base and prepared for a single-engine straight-in approach. At seven miles on final he became preoccupied with caution lights, and when he looked back outside, he found himself in a 30 degree yaw and 135 degrees of bank, nose low and passing through 900 ft AGL.

He ejected safely after realizing that the ejection handles were on the sides of the seat instead of between his legs where he had first reached. Prior to ejection, the possibility had not occurred to him. This lack of preparation and subsequent loss of valuable time could have cost him his life.

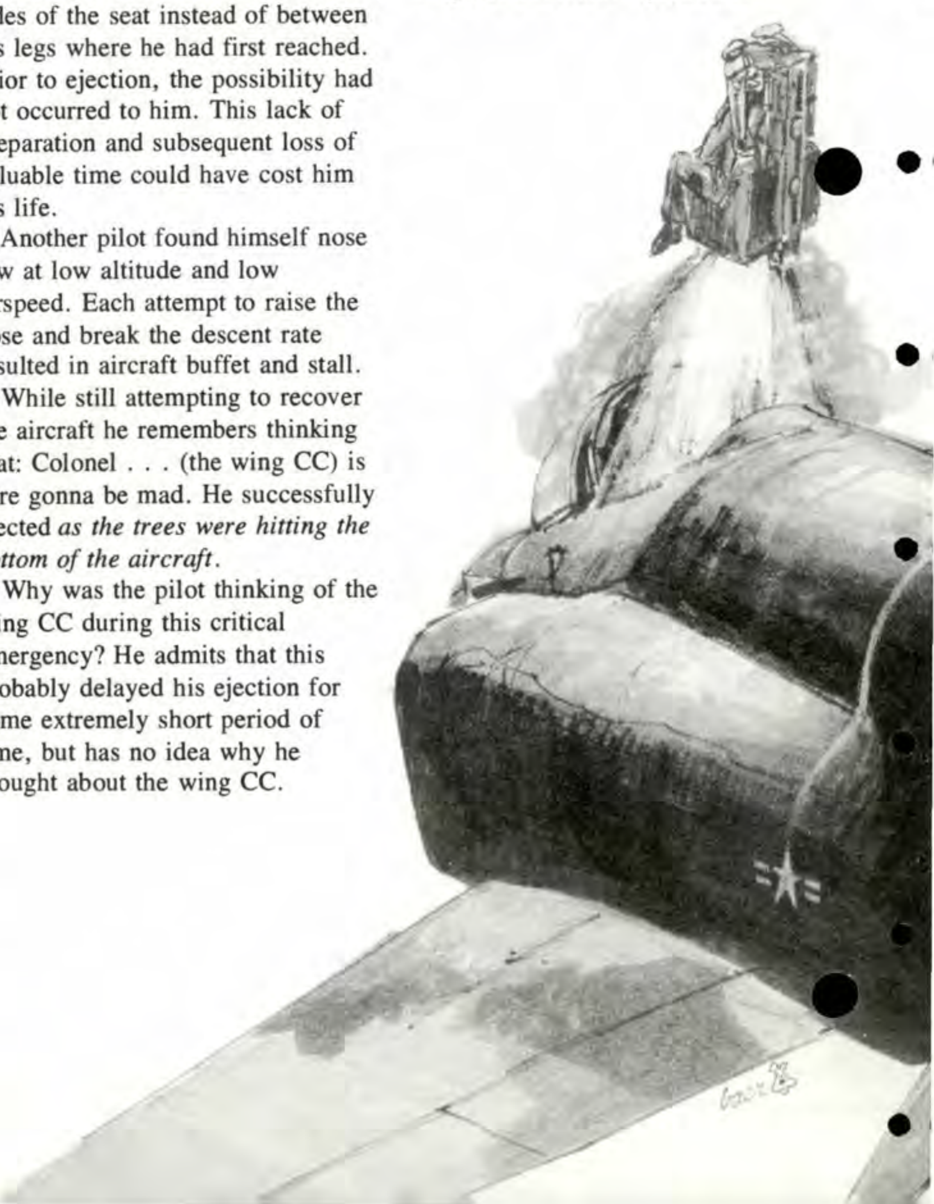
Another pilot found himself nose low at low altitude and low airspeed. Each attempt to raise the nose and break the descent rate resulted in aircraft buffet and stall.

While still attempting to recover the aircraft he remembers thinking that: Colonel . . . (the wing CC) is sure gonna be mad. He successfully ejected *as the trees were hitting the bottom of the aircraft*.

Why was the pilot thinking of the wing CC during this critical emergency? He admits that this probably delayed his ejection for some extremely short period of time, but has no idea why he thought about the wing CC.

These accidents bring a few things to light. Mishaps where crew members survived point to several reasons for delayed ejections.

Channelized attention is a possible factor. Most out-of-control situations that we practice in the simulator begin at an altitude above 10,000 ft. The response that the instructor is looking for is the "Out-of-Control Recovery." The situation may continue until ejection is



required, but always after recovery has been attempted. If you're at or near 10,000 ft AGL when you start the recovery procedure, you'll probably be out of the safe ejection envelope when you realize that ejection is required.

Lack of preparation is another possible factor. We, as pilots, can and must eliminate a large part of this risk. We have to fully understand the aircraft we are flying. Know what its capabilities are . . . what it can do . . . what it can't do . . . keep the machine in its envelope . . . but if things really get bad, we must be prepared to abandon the aircraft without hesitation or fear.

Know the seat you're flying in. Know its envelope. Give the bird an honest chance to fly, if time permits, but get out while you're still in the safe envelope of the seat. *Give it a chance to work for you.*

Fear of losing face or fear of reprisal may explain a person's lack of decision. We are all influenced by our superiors and our peers. We must all be aware of the influence that our attitudes and perceptions have on others. The system cannot tolerate willful violations, disregard of standard operating procedures, negligence, etc.

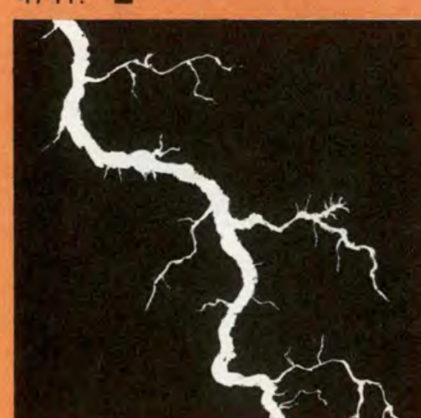
Neither can we tolerate the attitude of "hang the pilot" for honest mistakes. We have to accept that mistakes will be made. Not only by the "young tigers" but also by the "old heads." Our attitudes must reinforce the idea that aircrew members are more important than hardware.

The ultimate decision to "Eject or Die" rests with the pilot. Know your aircraft. Know your ejection seat. Don't let fears or misconceptions delay your ejection from a hopeless aircraft. ■

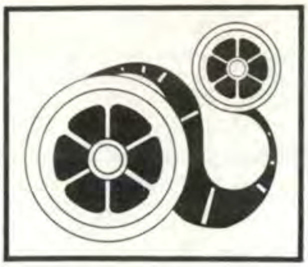
New Seminar On Lightning

■ Air Weather Service (AWS) developed a 15 minute 35mm slide and tape seminar for aircrews on the hazards of lightning strikes and electrostatic discharges. These are the leading causes of reportable weather-related USAF aircraft mishaps. The seminar includes discussions on thunderstorm lightning, aircraft triggered lightning, electrostatic discharge, the effects of lightning on aircraft and aircrews, meteorological conditions where lightning strikes occur, what to do to avoid or reduce the probability of a lightning strike, and some of the things to do if struck by lightning.

The Air Force Inspection and Safety Center recommends all aircrews see this seminar as soon as possible. Each weather detachment has a copy available for loan. Additionally, AF flying units can obtain a copy from AAVS through their Base Film Library. The seminar is titled "Lightning Strikes to Aircraft" and the AAVS number is STT-Q9-0113.—Capt Lehneis, AWS/DNTS, AUTOVON 638-4741. ■



OPS topics



Low Level Training Film TS 1414, "Visual Illusions"

■ "Visual Illusions," (TS 1414), a new low level training film, is now available in video tape form. The show deals with distortions in perception caused by terrain features which can be encountered during low level flying. The 16mm version of this film should be available by 30 November 1979. Contact your local audiovisual shop to obtain the show and order by number: video tape – VC3 TS 1414; 16mm film – TS 1414. – Maj Gary L.Sholders, Directorate of Aerospace Safety.

Misaligned Landings

Remember one of the first things you were told as a student pilot was "If it doesn't look right, take it around." Here's why.

■ After going heads up at 220 ft AGL, the pilot of a C-141 attempted to line up with the runway by banking right. At that point GCA called "minimums, slightly right of course, runway is on your left." The pilot then banked left and, as he crossed the threshold, saw the aircraft was drifting left of centerline and corrected again to the right. Touchdown was soft and everything appeared to be okay. Post flight revealed the right wingtip had dragged on the runway.

■ A student pilot flying a KC-135 attempted a last minute correction to line up and started his flare a little high. The IP tried to salvage the landing but the nr 4 engine cowling scraped. The ensuing fire damaged six feet of cowling and several components.

■ Fighters may be more nimble, but . . . An F-4E pilot with radio problems saw the runway at GCA minimums 200 ft to the right. His wingman called for a go around, but the message was not received. The mishap pilot continued the landing by turning right but decided to go around just prior to touchdown. However, the aircraft touched down in a right drift slightly right of the centerline, on a wet runway. Wind was from the left. The aircraft right main tire left the runway, but the pilot flew the aircraft out with no damage.

There But For . . . Go I

The photo on the back cover was taken the day after two highly qualified pilots were on a proficiency flight in a high performance fighter. After about 30 minutes of flying time, while the front seater was sweating out an instrument approach at a nearby air patch (under VMC), the back seater decided it was time for a smoke. He unfastened his oxygen mask, folded his glove and placed it in the mask to cut down the noise for the front seater, lit up a fag and POW!! A flash fire that lasted about 3 seconds ruined his whole beautiful day. How many of us have done the same thing and lucked out?

The final results of one second of forgetfulness: second degree burns on his right hand and wrist, a severe reprimand from the boss, two to three weeks of no flying, a chagrined pilot and a lot of grief from the rest of the troops.

Did You Know?

The temperature rise in aircraft tires on takeoff roll is less than a third of the tire temperature rise resulting from taxiing approximately 3 statute miles? Improper taxi techniques can contribute to an insidious buildup of heat due to kinetic energy absorption during taxiing. This heat can deteriorate the sidewall structure of the tire, producing a blowout – perhaps during a critical phase of takeoff.

Overheated brakes can kill. . . .

Overheated tires will let you down, suddenly! – Courtesy RAF *Flight Safety Digest*, Spring 79.

Winter Stuff

With winter coming on, we can expect a few problems associated with the cold season. Since forewarned is forearmed, we're recounting a few events from last winter as a reminder.

An 0-2 operating at a municipal airport landed in the overrun because the overrun border lights and threshold lights were obstructed by snow to final approach slant range visibility. The 19-inch snow depth collapsed the nose gear. Subsequently, the front prop was bent and the front engine torn from its mount. Both pilots were shocked to discover that they had landed on the overrun, not the runway. It happens nearly every year — be alert.

An aero club Cessna 172 was extensively damaged during landing when the aircraft struck a snowbank. At touchdown for a full stop landing, the aircraft veered right. Power and left rudder were applied but the engine coughed and stalled. Carburetor heat was full on. The aircraft then plowed into the snow beside the runway and nosed over. Investigators believe a brake was locked by ice and that sudden application of power with an excessively rich mixture caused the engine to stall. The rich mixture is common at cold temperatures — in this case 0°F. Brake lock was thought to have been caused by brake heat from taxiing, melting snow, and the moisture freezing on the brake pucks after takeoff.

During the past year, there have been several instances when aircraft and other vehicles have shared the runway at the same time. That, of course, is not good. Here's an example: KC-135 landing, pilot sees dark objects at departure end of runway. He decides to accelerate for takeoff and leaps off at the 6,000 ft point when the dark objects are defined as a truck and snow plows. This incident resulted from poor visibility caused by patches of ground fog on the runway and controller complacency. Although the red light denoting vehicle on the runway was on in the tower, no one noticed it, and the controllers could not see the snow plows because of the fog.

Herc Hits CAT

Puma? Lynx? Well, no, it all started with a good weather forecast. Our intrepid Herc captain set off on a trip up the east coast of Canada. After ascending to avoid some prowling CBs, he hit the CAT. To quote: "Large variations in aircraft altitude and rapidly changing G forces started to occur. The AC pitched between 15° nose up and 20° nose down with up to 50° of bank. The turbulence reached a stage such that the copilot found it difficult to operate the transmit switch to put out a *mayday*. The captain was faced with marginal control and the feeling that the ship was about to 'stress relieve' by falling apart."

Luckily, they descended out of the CAT before the AC was structurally damaged. Nearly a fatal accident because of a lack of information on the weather. If you are warned about CAT, steer clear (? no pun intended), you could get very shaken up . . . structural failure at FL290 leaves you a long way up, and a quick way down. And if you are really clever, you can predict CAT areas by looking at the weather charts — no I'm not going to tell you, ask the Met Man! — Courtesy RAF *Flight Safety Digest*, Spring 79. ■

A LOOK AT Brake Cooling

By **WALT BLAKE** • The Boeing Company

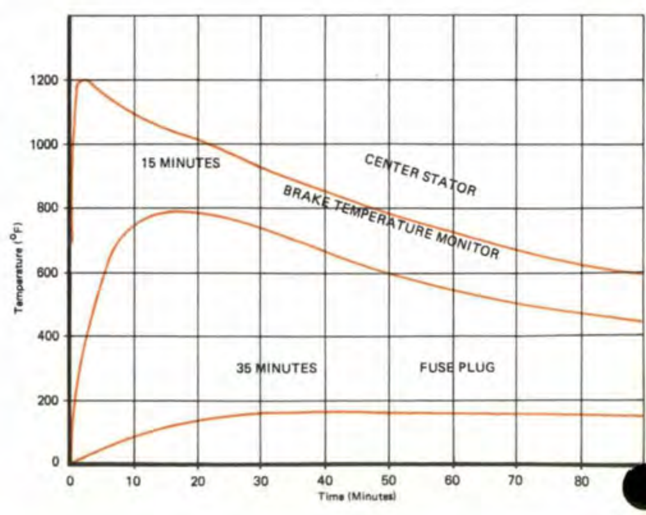
■ Consider the following scenario: An aircraft makes a normal landing following a routine flight. After taxiing two miles to the ramp, it is parked for an hour and a half, in preparation for the next leg. The airplane is then taxied several more miles to the active runway and the takeoff roll is begun. At approximately 110 knots, the pilot rejects the takeoff (RTO) and the airplane is taxied off the runway. After checking the problem that caused the RTO and deciding to continue the flight, the crew determines from the brake cooling chart that the brake energy from the RTO is below the "caution" range. They therefore taxi back and proceed to take off. Several tires fail during the takeoff and the thrown pieces of tread cause considerable damage to the airplane; more damage is incurred during the subsequent landing. The airplane is grounded two weeks for repairs.

Fiction? Not at all . . . although it was an unusual combination of circumstances, it did happen, and there have been a number of similar incidents. Most of them were avoidable.

The Cause

The underlying cause of these incidents is a lack of awareness of the essential facts concerning airplane brakes:

- The kinetic energy which is absorbed in stopping the airplane is converted through friction into heat energy.
- The brakes dissipate this heat very slowly. Depending on many variables, an hour of ground cooling will



reduce the temperature by only one-half or less.

- Heat energy is cumulative. A typical flight and taxi sequence can progressively increase the brake temperature to a significant level.
- Even a moderate kinetic energy absorption by a brake which is already hot can cause the wheels to reach a temperature high enough to melt the protective fuse plugs. This will result in tire deflation.
- Depending on the energy absorbed, tire deflation can occur at a time ranging from only a few minutes to almost one hour after the energy has been absorbed.
- Failure of a tire is, for all practical purposes, the same as failure of a brake; tire failure during an RTO or a landing will thus increase the distance required to stop the airplane. It will also increase the amount of energy which the remaining operational brakes must absorb and therefore will increase the possibility of melted fuse plugs in those wheels.

In the above incident, the brakes were still hot, but within limits, at the time of the RTO. The RTO energy absorption was enough to raise the brake/wheel temperatures to a point which resulted in tire deflation. The deflation, which probably occurred during the taxi back to the takeoff point, was not detected. The takeoff on the flat tires caused their failure and the ensuing airplane damage.

The Prevention

- Use good pilot technique during landings and taxiing to minimize kinetic energy inputs to the brakes. Prompt extension of the speed brakes, proper use of reverse thrust, and judicious application of the brakes are important. Careful control of the touchdown speed and touchdown point are essential.
- Any landing at a weight exceeding the certified maximum "quick turnaround" weight, or any rejected takeoff, is cause to stay on the ground long enough to ensure that the tires will not deflate.
- Use of in-flight gear-down brake cooling can reduce residual heat energy very rapidly and is recommended particularly for short-haul operators to whom cumulative heat energy can be a serious problem. It is also valuable on training flights making full stop or stop-and-go landings. The gear-down cooling can be accomplished either by delayed gear retraction after takeoff, performance permitting, or by early extension on approach.

Sources of Kinetic Energy

There are two airplane maneuvers which may require the brakes to absorb large quantities of kinetic energy: Landings and rejected takeoffs.

Rejected takeoffs from high weights and speeds, which fortunately are rare, represent the most extreme use of the brakes, since an RTO is typically at a higher weight than a landing, and available stopping distances may be significantly shorter than during a landing. The RTO speeds may be as high as, and in some cases higher than, the landing speeds. A maximum-energy RTO will require replacement of the wheels, tires, and brakes.

Even at the same weight and brakes-on speed, an RTO requires the brakes to absorb more energy than a landing because:

- The airplane during an RTO has less aerodynamic drag, due to the smaller flap setting.
- An RTO is initiated while the engines are producing takeoff thrust, compared to a landing in which the brakes are applied with the engines already at idle thrust.

A significant source of energy which must be absorbed by the brakes, largely overlooked but nevertheless very important, is taxiing. Depending on engine thrust and airplane weight, it is often necessary to use the brakes simply to keep the airplane from accelerating to an unacceptable taxi speed. In addition, taxiing requires full stops at times.

Energy Accumulation

It is essential to understand that heat energies are cumulative. Examine a conceivable flight sequence beginning with the landing: The landing by itself requires a moderate amount of kinetic energy to be absorbed by the brakes. When the landing is followed by taxiing, more heat energy is added to the already heated brakes. Parking the airplane for normal turnaround times does not fully cool the

A Look At BRAKE COOLING continued

brakes since the heat is dissipated quite slowly. Taxiing out for the subsequent takeoff adds still more heat energy. In the event of even a moderate RTO, then, the brake/wheel temperatures may be raised above the point at which the fuse plugs will melt.

Let's look at an example of brake energy accumulation in a representative airline operation. A 737 leaves Seattle for its first flight of the day to Portland, San Francisco and Los Angeles. The brakes are cool before the landing at Portland, but the 95,000-pound landing, plus the taxi-in, requires the absorption of approximately nine million foot-pounds of energy per brake. About three million of these will be dissipated during the half-hour ground time, but the taxi out will add a million.

As the airplane leaves Portland, then, each brake contains seven million foot-pounds of residual energy, only about two million of which will be dissipated during the one-hour flight to San Francisco. Landing there at 90,000 pounds plus taxiing, leaves each brake with about eight million foot-pounds at the time of takeoff. Obviously then, an RTO of moderate to high energy will put the brakes well over the fuse plug melt energy of 20 million foot-pounds. Even without an RTO, the short flight to Los Angeles means that the landing there will be made with some seven million foot-pounds remaining in each brake.

Temperature Time History

We have been talking about the slow dissipation of heat energy. To illustrate this, let's look at a chart of temperature versus time for a hot brake. Figure 1 shows the time-temperature history of a 747 brake following a 30-million foot-pound energy input – a moderate RTO.

Notice that the center stator, the hottest portion of the brake, almost immediately reaches its peak temperature of 1300°F and then begins the long slow process of dissipating its heat. Even after 90 minutes, the center stator is in excess of 650°F, ABOUT ONE HALF OF THE INITIAL HEAT ENERGY IS STILL IN THE BRAKE.

Notice also that the fuse plug does not reach its peak temperature until 35 minutes after brake application. This lag is due to the relatively slow flow of heat from the brakes outward into the wheels. The time lag between the brake and fuse plug temperatures depends on the energy absorbed – in the extreme high-energy case, the fuse plugs will melt within a few minutes.

A brake temperature sensor is installed on most 747's. The sensing element is located in the backing plate at the extreme end of the brake stack which is the only member of the brake heat sink which is static and therefore available for installation of a probe. This location, at the end of the brake stack, is not the hottest part of the brake immediately after a stop. The backing plate temperature continues to rise, and the center stator temperature drops, until the entire heat sink is at the same temperature. As a result, there is an appreciable time lag to the temperature indication, again due to the relatively slow flow of heat from the brakes outward. The lag will be as much as 15 minutes.

Brake Cooling Methods

In-flight cooling with the landing gear extended is by far the most efficient method of brake cooling and is especially useful for those training flights used to practice takeoffs and landings. Some airlines utilize gear-down inflight cooling after takeoff following a short turnaround, especially when the upcoming flight segment is brief, in order to ensure landing with reasonably cool brakes. When feasible, it is also effective to extend the landing gear somewhat early during the landing approach following a short segment.

Brake cooling when the airplane is parked is only fractionally as effective as in-flight gear-down cooling. Several hours may be required to cool the brakes to ambient temperature after a typical landing. Some airlines have adopted the practice of using large electric fans with airflow directed over the wheels and brakes to speed brake cooling when parked. The 747 has an optional brake cooling fan mounted within the wheel which has proven to be very effective.

Slowest of all is brake cooling with the landing gear retracted in flight, which is less than one-third as effective as on-ground parked cooling. To improve gear-up cooling, some airplanes have airscoops which direct cooling air through the wheel well in flight. – Adapted from a longer article in the *Boeing Airliner*, July 1979. ■

THE PROFESSIONAL APPROACH

AIR FORCE COMMUNICATIONS SERVICE
Scott AFB, IL

■ Q. How can I get an instrument approach procedure published?

A. This question has been asked many times by Air Force pilots who go into civil fields where approaches are being conducted and there are no similar procedures in the DOD FLIP. It is also asked by wing commanders and DOs who need a new approach to their airfield.

The answer is in AFR 60-27, "Flying Instrument Procedures." This regulation explains how IAPs are established, approved, reviewed and revised. It applies to all Air Force flying activities including ANG and AFRES units.

The first step is to formally make your request known for a procedure (departure, STARS, or instrument approach). Your request is made through the responsible Air Force Communications Service (AFCS) unit. Operations personnel assist AFCS personnel in developing, revising, monitoring and deleting procedures.

The second step is where the AFCS unit develops the procedure according to the needs of the host base or prime user, or requests the FAA to develop a procedure. To do this the AFCS unit needs civil engineering support for the data required to develop a procedure. This data includes surveys of airfield, obstruction data, field lighting capability and current engineering tabs from the base comprehensive plan. If the surveys are not available it may take 6 months to 1 year to get a complete, accurate survey for a base. The procedure is then drawn on the maps and charts and all obstacles are plotted and basic minima are determined by using the proper mathematical calculations. Because of the obstacles, this step may have to be repeated several times before the desired landing minima are finally achieved. A request for a waiver to terminal instrument procedures (TERPs) criteria may be required if the criteria are violated to get down to the approach minima that are desired.

The next step is local coordination at base level. This usually takes place with the wing commander or DO, stand eval, and line pilots all taking a look at the new procedure. If this will be a completely new procedure, then an environmental assessment may have to be completed. Once again, this consumes time.

Then comes the flyability check using the proper type aircraft to determine if the procedure is safe and flyable. The complete procedure is checked from a pilot's point of view. This check includes flyability and cockpit workload. This may require a few more adjustments or a complete overhaul of the proposed procedure.

The procedure package is now becoming pretty thick with maps, charts, letters and forms all put together to justify this procedure and its minima. The next step is for the AFCS unit to forward the package to the proper FAA/ Host Nation air traffic control personnel for their coordination and approval. A formal flight inspection by AFCS or FAA fight inspection personnel is requested. This inspection certifies that the navigational aid being used is capable of supporting the procedure. The signed package is returned to the AFCS unit who in turn forwards it to their headquarters for approval. Then the package is sent to HQ AFCS or to Defense Mapping Agency Aerospace Center (DMAAC) as required.

If a waiver is needed, more coordination is required and approval is needed from the Air Staff. The entire sequence of events is outlined in AFR 60-27. What you, the original requester, need to keep in mind is the amount of time it takes to develop, review, and publish a procedure. Many people have to do a lot of research and that takes time. The additional coordination for waivers sometimes makes one wonder if the approach procedure was worth the wait.

The approach will now be published and then revised or changed as new obstacles are built and old obstacles are removed. This means that the approach must be continually monitored for accuracy. In addition, each year the host base along with the AFCS unit reviews, revalidates, and advises HQ AFCS of the requirements for all terminal instrument procedures at that base.

To revise or change an approach may mean the same steps will be taken all over again. If a frequency, facility identification or other minor changes are made, then the change can be made as advertised in

continued on page 28

PRO APPROACH continued

FLIP. Any procedural change should be supported by at least an abbreviated package with the supporting documents. This package and documents should be processed through the local AFCS unit, up the chain as depicted in AFR 60-27. To delete a procedure you must go through the same steps again. This will ensure that a procedure is not deleted while it is still required by other services or agencies. Thus, as you see, the development and maintenance of an approach procedure is a complicated and tedious one, yet needed to ensure that the procedures are safe and flyable for the user.

Host nation (foreign) procedures will be processed in a slightly different manner. In either case, host nation or US, the local AFCS unit should be the focal point for all procedures and should be able to answer any questions you have on your procedures and probably give an insight to procedural questions at other locations. If you have a question they are the experts you should check with first. ■

How long can you hold your breath?

CAPTAIN ROBERT L. SEELEY
HQ ATC/IGFF
Randolph AFB, TX

■ Recently, two separate but similar physiological mishaps occurred. One involved an F-5 pilot (lots of experience), the other a T-38 student pilot (not so much experience).

Both pilots became hypoxic when they became disconnected from their oxygen hoses at the CRU-60 P connection. Additionally, both pilots were slow to recognize and correct their malfunctions, for various reasons. The oxygen hose retention strap turned out to be a contributing factor. An improperly adjusted retention strap can reduce the effective hose length from the seat to the pilot's CRU-60 P connector. As a result, during normal body movement the oxygen hose can become disconnected and cause problems. It can also be difficult to reconnect and readjust the oxygen hose and strap in flight.

The solution is to get everything adjusted *before* you take off. (Step nr 5 in the Cockpit (All Flights) Checklist.) The strap is designed to facilitate a clean man/seat separation so it's important to have it properly adjusted. Check the strap when you make your initial cockpit check before the walk around. Make sure you've got enough hose available. The strap *should not* slide too easily. (If it does, it could change adjustment during flight.) If the strap does move too easily, you can use one of the intercom/oxygen hose rubber positioning straps to help locate the hose retention strap and keep it from moving.

Besides proper adjustment of the hose retention strap, there is another circumstance which can cause problems – namely, oxygen hose length. Evidently, over the years various oxygen hose lengths have been used in the T-38. These included 36-inch, 14-inch, and the current 30-inch version. Several years ago they began changing out the then current 24-inch hoses with 30-inch ones on an attrition basis. As a result, there are still some 24-inch hoses in service. A 24-inch hose will most likely be too restrictive for most crew members. So, if you find a hose that you think may be too short, write it up and get it checked/replaced.

It's important that you understand how to adjust all your personal equipment and connections to maximize their benefits. Talk to your life support and egress people if you have any questions. Preventing problems on the ground is a lot easier than solving them in the air. ■

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UNITED STATES AIR FORCE

Well Done Award

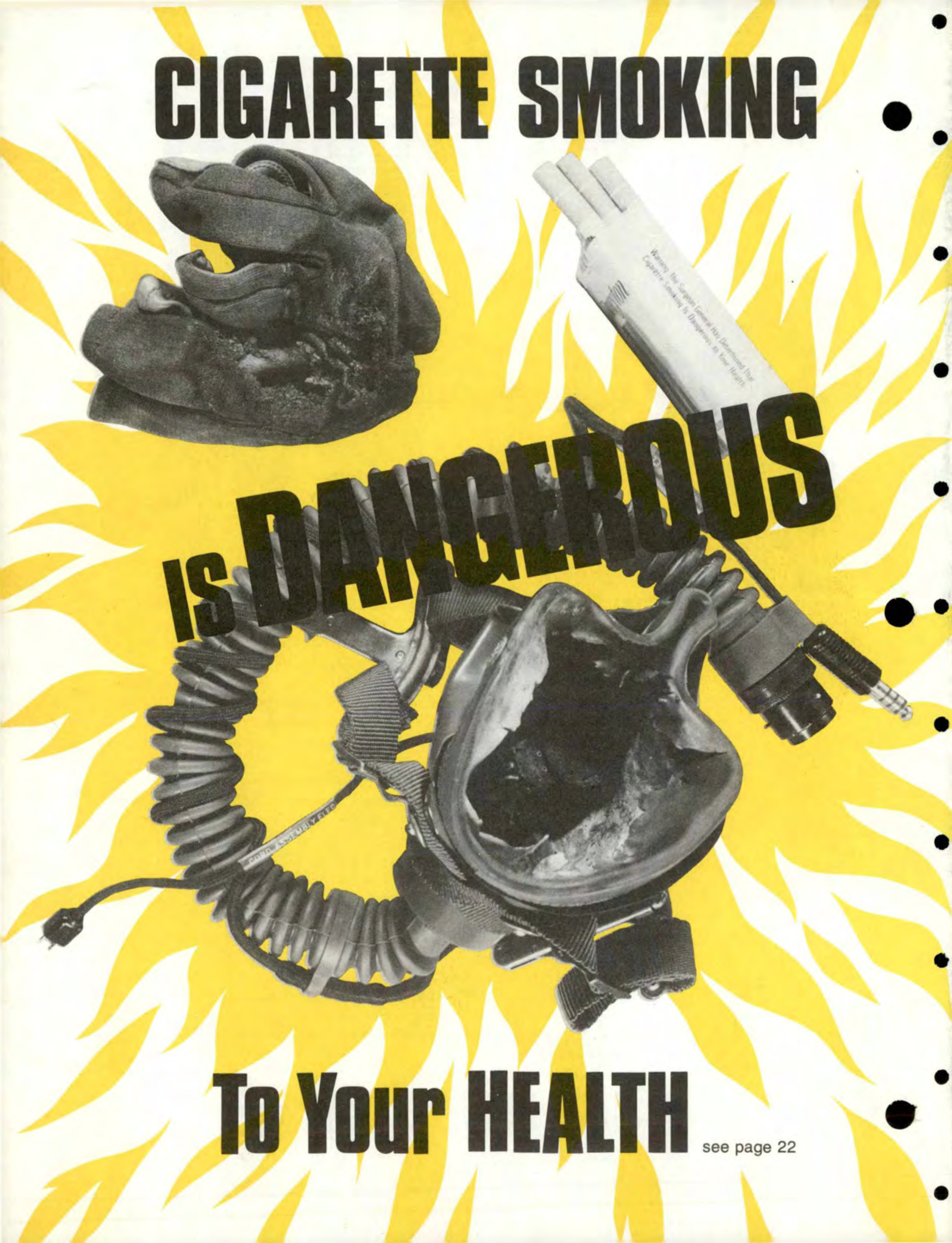
Presented for outstanding airmanship and professional performance during a hazardous situation and for a significant contribution to the United States Air Force Accident Prevention Program.

FIRST LIEUTENANT
Spencer J. Roberts

CAPTAIN
Patrick C. Welch

50th Tactical Fighter Wing

■ On 2 September 1978, Lieutenant Roberts and Captain Welch were on a cross-country flight in an F-4E. Both were inexperienced, having under 300 hours in the F-4. Halfway through their mission, over the middle of France at FL 330, severe engine vibration and loss of thrust occurred on the number one engine. As the oil pressure dropped rapidly to zero and vibrations increased, the engine was shut down and an emergency declared. The F-4E was heavily loaded with a centerline and two external fuel tanks and a travel pod. The partially seized engine made high altitude flight inpossible, and a rapid descent ensued. Level flight was achieved at 5,000 feet above sea level. At this point, the nearest USAFE base was 160 nm away, on the other side of the 11,000 foot Pyrenees mountains. Immediate calculations were made based on airspeed, fuel and drag indices. The only runway of sufficient length within range was a civilian field 70 nm away in the south of France. An initial heading vector was taken off the inertial navigation system which was known to be off by five miles. The weather at the civilian field was two miles visibility with haze and a broken 1,500 foot ceiling which made map reading difficult. The aircrew used dead reckoning to find the approximate position of the airfield. The problem of descending through the clouds, approach, and landing was complicated by no TACAN, GCA, VASI's or voice contact with the field controlling agency. A letdown was flown using the radar altimeter, INS updated steering, and an airborne radar approach backup into the haze below the clouds. In the haze, fighting disorientation and a now critical fuel state, a systematic search pattern was flown to find the airfield. After finding and visually clearing the runway, the crew made a perfectly executed single engine approach and landing. Lieutenant Roberts and Captain Welch demonstrated exceptional composure and professional skill in handling an emergency that could have resulted in the loss of the aircraft. WELL DONE! ■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IS DANGEROUS
To Your HEALTH
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Warning: The Surgeon General Has Determined That
Cigarette Smoking Is Dangerous to Your Health.