UNITED STATES AIR FORCE • FEBRUARY 1969

Aerospace SAFETY

THE MAGAZINE DEVOTED TO YOUR INTERESTS IN FLIGHT

A New BAK • What Are Your Intentions?
Stress Corrosion • A Dreadful Disease • CAT Primer

LIGHT PLANE - 12 O'CLOCK

WHY YOU CAN SEE AND NOT SEE

Aerospace SAFETY

THE MAGAZINE DEVOTED TO YOUR INTERESTS IN FLIGHT

February 1969 AFRP 62-1 Volume 25 Number 2

SPECIAL FEATURES

REGULAR FEATURES

SUBSCRIPTION—AEROSPACE SAFETY is available on subscription for $3.50 per year domestic; $4.50 foreign; 30c per copy, through the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402. Changes in subscription mailings should be sent to the above address. No back copies of the magazine can be furnished. Use of funds for printing this publication has been approved by Headquarters, United States Air Force, Department of Defense, Washington, D.C. Facts, testimony and conclusions of aircraft accidents printed herein may not be construed as incriminating under Article 31 of the Uniform Code of Military Justice. All names used in accident stories are fictitious. No payment can be made for manuscripts submitted for publication in the Aerospace Safety Magazine. Contributions are welcome as are comments and criticism. Address all correspondence to the Editor, Aerospace Safety Magazine, Deputy Inspector General for Inspection and Safety, USAF, Norton Air Force Base, California 92409. The Editor reserves the right to make any editorial change in manuscripts which he believes will improve the material without altering the intended meaning. Air Force organizations may reprint articles from AEROSPACE SAFETY without further authorization. Prior to reprinting by non-Air Force organizations, it is requested that the Editor be queried, advising the intended use of material. Such action will insure complete accuracy of material, amended in light of most recent developments. The contents of this magazine are informative and should not be construed as regulations, technical orders or directives unless so stated.

Brigadier General Benjamin H. King has been assigned Director of the Directorate of Aerospace Safety, replacing Brigadier General Frank K. Everest, Jr., who has been reassigned to the Pentagon.

Prior to coming to Norton, General King was Inspector General for the Aerospace Defense Command. During World War II, he served in both the Asiatic-Pacific and European-Middle East theatres, logging 122 combat missions and destroying seven enemy aircraft. He also flew 200 combat missions during the Korean War, and 100 missions in Vietnam while assigned to Southeast Asia in 1963-64.

PREFLIGHT

Kicking off this issue of Aerospace Safety is "Light Plane—12 O'clock," an account of a midair collision and some of the physiological factors present during every flight. The author, Lt Col Victor Ferrari, a flight surgeon, discusses some of the limits to human vision in the flight environment. Recommended reading for all pilots.

For aircrews flying hook-equipped aircraft there are charts on the new BAK-13 arresting system and a brief article describing the system and how it works. You'll find it on page 9.

"CAT Primer," page 22, is another how-to-item that should be of interest to all aircrews, since it provides some clues as to where to expect turbulence and means of avoiding it.

12 O'CLOCK LIGHT PLANE

Lt Col Victor J. Ferrari, USAF, MC, Life Sciences Group
Directorate of Aerospace Safety

Several months ago a light aircraft collided with a jet fighter. The light plane crashed but the fighter received only minor damage. This is an account of that accident and the various factors involved.

The early morning briefing for Yankee Flight (four tactical fighters) included a warning about high density light aircraft traffic on the departure route. After takeoff the flight remained under radar departure control as long as it was available, and the aircraft flew an extended formation to provide maximum visual clearance.

After leaving radar control they entered an area designated a high volume jet operation area. Civilian aircraft are *encouraged* in the AIM to remain at or below 5000 feet in this area. Yankee Flight entered the area at approximately 8000 feet and began a shallow climb at 420 KTAS.

Meanwhile, a light aircraft was transiting the area on a course approximately parallel to the fighters' route of flight. Less than one minute prior to the accident, the pilot of Nr 2 moved into closer formation (one ship spacing) to check a malfunction of the right external fuel tank on Nr 1. He visually cleared the area prior to this maneuver and had just stabilized in this position and was viewing the tank when he heard Nr 3 (voice recognition) call "Light plane — 12 o'clock." This was approximately 15 seconds after Nr 2's last visual scan. *Two* looked up and saw a "light colored" blur which passed between him and Nr 1. He did not feel any contact with the civilian aircraft but later investigation revealed that the vertical stabilizer of the fighter sheared off 41½ inches of the light aircraft's right wingtip. The fighter had no control problem and "capped" the crash scene until a helicopter arrived. The light aircraft went out of control, disintegrated, and crashed.

The lead pilot said that just prior to the call from Nr 3 he had been scanning ahead and did not see the aircraft prior to the call. Nr 3 had been clearing the area for other aircraft during the time that Nr 2 was checking Nr 1. He suddenly saw the small aircraft less than 300 feet in front of Nr 1 and 2. By the time he yelled "Light plane—12 o'clock," it had passed between Nr 1 and 2.

Yankee 4 said that he was scanning through Nr 1 and 2's position at the time Nr 3 called the bogey. He then saw the civilian aircraft "right on top of Nr 2." He also said the flight path was parallel to that of Yankee Flight and the attitude was level flight.

A question that immediately arises is, how could four pairs of eyes fail to see the other aircraft in time to prevent the collision? The investigation of this accident disclosed many reasons of vital concern to all segments of aviation.

First, it should be established that the pilots in Yankee Flight were highly experienced with extensive fighter backgrounds. They had been intensively trained in keeping their heads out of the cockpit. They represented the most proficient group in the USAF at visual detection of other aircraft in flight.

Visibility was good at the time of the accident, being reported as 5-10 miles by various members of Yankee Flight. However, there was a definite haze condition which decreased c o n t r a s t of colors and shapes. For example, the mountains were seen as indistinct outlines. "Visibility was good but the background was indistinct" and "everything was seen as against a blue/grey background," are descriptions of the environmental conditions received from two of the pilots. This haze condition, typical of the desert, made visual perception of the white and turquoise light plane very difficult. Hazy sunlight desaturates color and contrast and makes things

WHY YOU SEE OR DON'T SEE

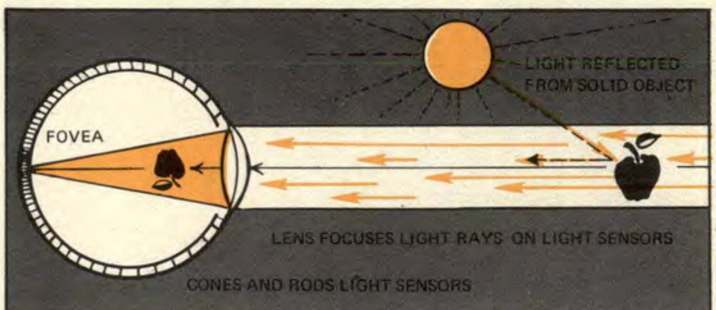


Fig. 1

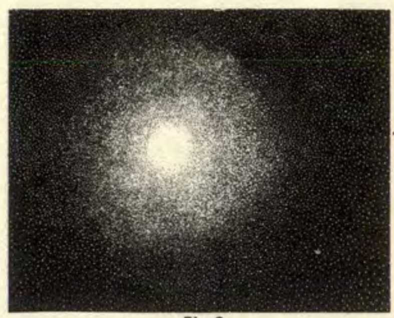


Fig. 3

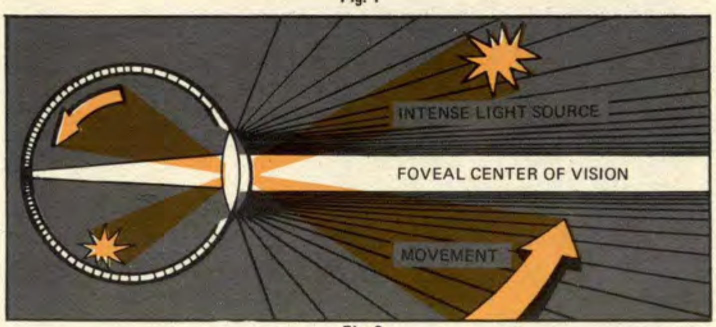


Fig. 2

Fig. 4

Vision is a combination of physics and psychology. Although the following is an oversimplification of a complex phenomenon, it is intended to present concepts useful to the airman in routine visual flight. We "see" when a light ray strikes the retina of the eye and stimulates light sensitive cells, which in turn send a message to the brain. Psychologically, we can notice or ignore this message, the strength of which depends on the intensity of the light and/or the number of cells stimulated. These cells are of two types: rods and cones. The rods are the cells most responsible for night vision, being sensitive to very low intensity light. The cones operate in high intensity light, e.g., daylight. They are responsible for point discrimination or good visual acuity. These cells are distributed unevenly in the retina with the cones being densely concentrated at the central point called the fovea. They are progressively less numerous outward from this point.

Figure 1 shows an image being transmitted through the lens of the eye and focused on the fovea of the retina. This is an example of **focused** or **foveal** vision and on this depends the discrimination of small distinct objects at various distances. Figure 2 is an illustration of peripheral vision, or unfocused vision. Here, because of the relative scarcity of cones, visual acuity depends on an intense source of light or relative movement which will stimulate many cells. As you would expect, your visual acuity with peripheral vision is very poor.

look grey. This phenomenon increases with distance. In this case, the civilian aircraft would blend perfectly with the background haze at a distance of one mile. The position of the sun, behind the fighters, prevented spectral reflections which could have been seen through the haze.

This is borne out by the testimony of Yankee 3 and 4 who did not see the light aircraft until it "suddenly appeared," although they were actively scanning forward.

The light aircraft was on a parallel flight path with Yankee Flight. This was established by the testimony of the pilots, the wreckage fall out plot, the line of cleavage through the light aircraft wing and the symmetrical marks on both sides of the fighter's vertical stabilizer. The narrow angle of closure presented the minimal cross sectional area to Yankee Flight. Since the wings were white and only 6½ inches thick at the root, the only visible object was the fuselage which was 50 inches high and 42 inches wide.

More important, the parallel flight paths minimized any relative movement of the light aircraft until it was very close to Yankee Flight. Motion is a very important factor in peripheral visual perception, especially when there is low contrast of color, tone and shape. In this case, Nrs 1 and 2 did not see any motion until the light aircraft was upon them. Nr 3—500 feet to the left—was the first to see the light plane because his angle produced relative motion sooner.

Directed attention (looking directly at) is the most important factor in perception of small, low contrast objects. Proper scanning requires fixing the eyes on a distant, discrete point. If, for example, another object at the same distance were two degrees to the right of the object being focused on, the visual acuity regarding this object would be degraded by one-half. Or, to be seen as equally as large as the first object, it would have to be twice as big.

Fig. 5

Fig. 6

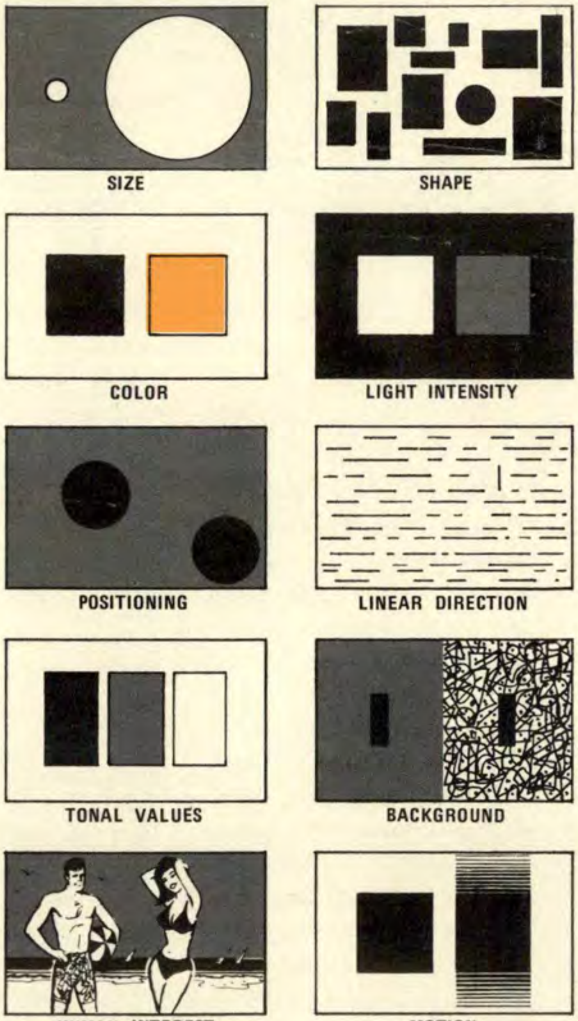


Figure 3 is a map depicting the distribution of cones in the back of the retina. The white spots depict the cones. Imagine these cones as holes through which you can see. Turning now to Figure 4, we see a photograph of a formation of aircraft. It is important to note the difference between the angle of focus of the camera which produced the photograph and that of the eye. A camera lens subtends an angle of from 18° to 80° depending on the design. However, the plane of sharp focus in a human eye is much smaller, being approximately 2° to 3°. Therefore, for the human eye to visually perceive all of the aircraft as depicted in the photograph, it must constantly move and refocus. It sees only a small part of the over-all photograph you see here. The brain, through its feedback mechanism, puts these small pictures together to form the large over-all picture we recognize psychologically. To demonstrate this, we superimpose Figure 3 on Figure 4 to give us Figure 5, which approximates the angle of vision of the human eye.

Figure 6 demonstrates the role of contrast in the psychophysiology of vision. Contrast of size, shape, positioning, background, etc, definitely influence your ability to see and perceive.

Figure 7 demonstrates another phenomenon very important to your ability to visually clear your flight path on a hazy day. We refer to altitude myopia or nearsightedness. This phenomenon occurs when the visual contrast of man's environment is decreased, e.g., at high altitudes, or as a result of haze, glare, etc. Essentially, when one focuses on a distant point through haze, the focus tends to recede back toward the eye with the passage of time, which simply means that it is difficult to continually focus on an indistinct object. The eye tires, relaxes, and we become "nearsighted."

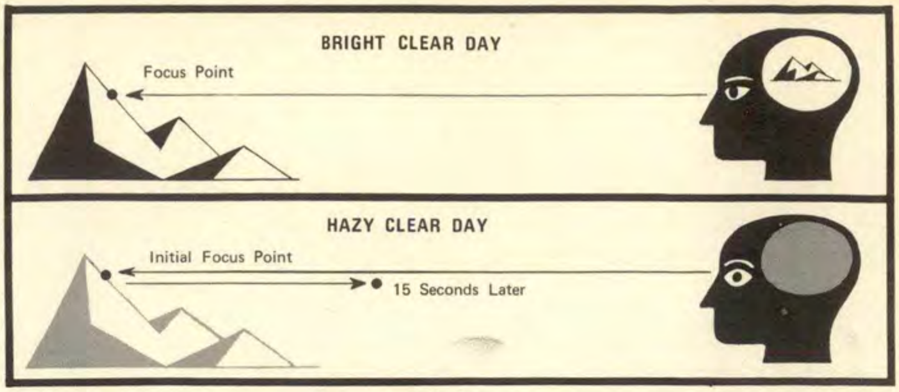


Fig. 7

This is extremely important because visual acuity is a function of the angle subtended by an object we are looking at. Figure 8 demonstrates that a smaller object would appear as large as a bigger but more distant object. Therefore, if altitude myopia occurs, a man might not perceive a C-5A at otherwise easily discernible distances. Figure 9 illustrates the decrease in visual acuity with the angular separation of an object from the cone of foveal (focused) vision. In Figure 9, a pilot's eyes are focused on aircraft "A." Note that aircraft "B" is outside his cone of foveal vision and much closer. However, the pilot's mental perception of aircraft "B" is hazy although larger, while aircraft "C," at the same distance as aircraft "A," is perceived as being much smaller and more indistinct. This assumes that all aircraft are the same size; therefore, objects regularly separated by only a few degrees from an object that you are focusing on become much harder to see, regardless of their size or distance.

Fig. 8

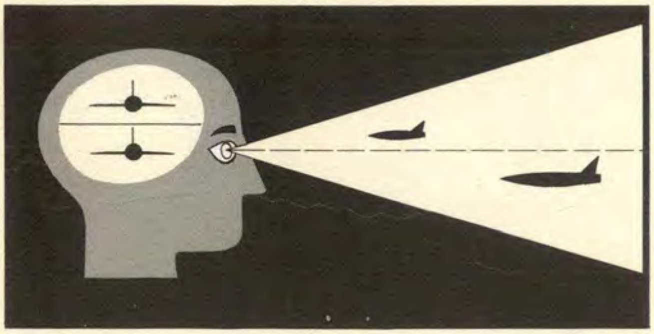
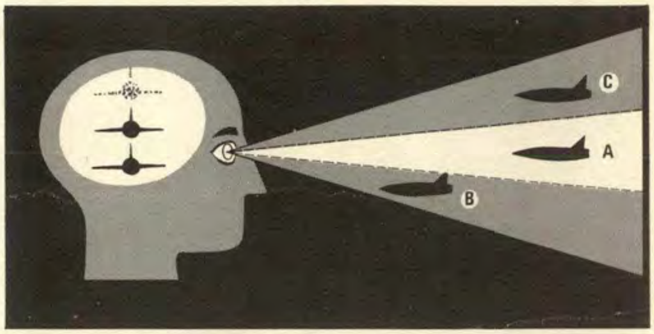


Fig. 9



Applying this to the case at hand, Yankee Flight would have to have been focusing at the correct range and within two degrees of the light aircraft in order to see it at the maximum possible distance. Under the conditions that existed, the flight would have had to be focused within five degrees and at the correct range in order to have seen the light aircraft at one-half mile.

Assuming the 5.5 miles per minute rate of closure and looking within two degrees of the light plane, the fighters would cover one-half mile before the average human being could perceive, react and change aircraft flight path.

An additional factor relating to the haze condition exists. This is "altitude myopia." Without sharp horizon reference, the focus of the human eye recedes from infinity. This markedly decreases distant visual acuity. Conditions which promote altitude myopia are flight at extreme altitudes and conditions of low visual contrast. The latter certainly existed at the time of the accident.

In determining human capability to have perceived and evaded the light aircraft, the distance that a person with normal vision could see the cross sectional area of the fuselage under optimum conditions, i.e., maximum color contrast, directed attention, and perfect environmental visibility and lighting, was calculated. Under these conditions a person with 20/20 vision could see a 4½ foot diameter object at a distance of approximately 2½ miles.

The TAS of the fighters was 484 miles per hour; that of the light plane was estimated at 150 MPH. This represents a closure rate of 5.5 miles per minute. Therefore, the light aircraft would have first come into visual range only 27 seconds prior to the accident under "eye lane" conditions. Interpolating the effect of the conditions discussed, it was the opinion of the investigator and the Physical-Physiological Optics Function of the Ophthalmology Branch, at the USAF School of Aerospace Medicine, that the light aircraft first came into visual

TEST YOURSELF

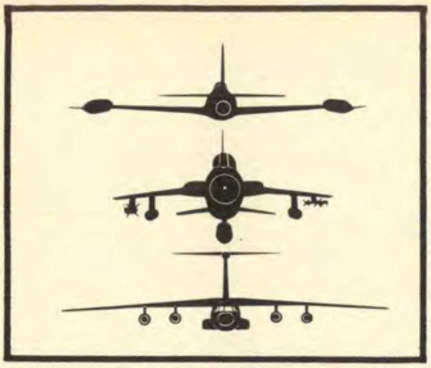
COVER THE BOXES AT RIGHT WITH YOUR HAND AND READ THE INSTRUCTIONS BELOW.

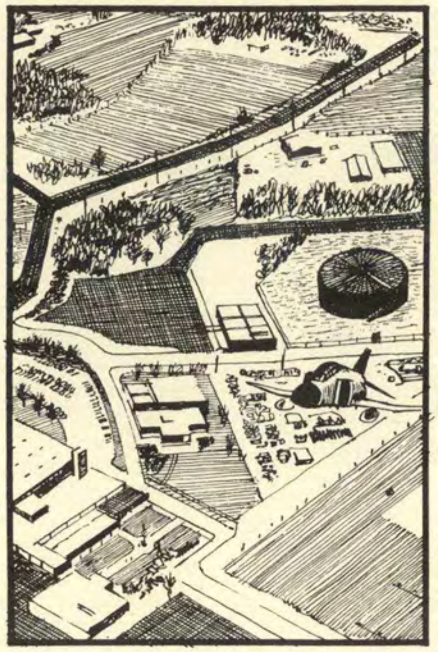
What do you see? To the right are silhouettes of various objects, including aircraft, and a scene such as would be viewed looking down from an aircraft. Concentrate your gaze on the spot labeled "Focus Here." Which of the aircraft at right represent a threat? Which is the biggest? Are they coming or going? Identify the various objects.

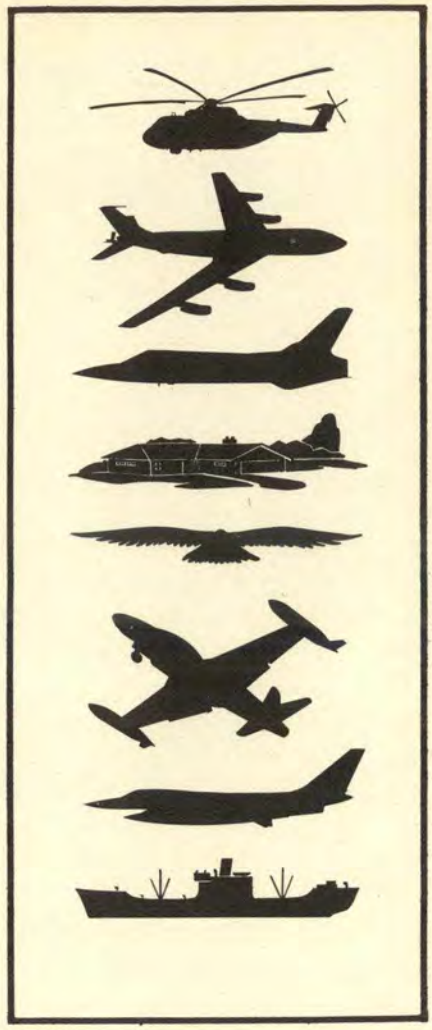
This test should give you some idea of how good (poor) your peripheral vision is. Remember that your eye will be focused at the same distance as these examples and there is good contrast. Compare this to the varying conditions in flight and draw your own conclusions as to your visual limitations.

●

FOCUS HERE







range at a distance of one mile. This pre-supposes predirected vision and the absence of high intensity light reflections or transmissions from the light aircraft. Therefore, it became visible 15 seconds or less prior to impact. Considering the time required for man to perceive, react and effectively change the flight path, Yankee Flight had only 5 to 10 seconds in which to see and evade the light aircraft.

The primary purpose of this article is to point out some of the visual factors that operate in maintaining separation between aircraft. Our eyes, of course, are invaluable aids to preventing collisions but we must understand the limits of human vision and some of its peculiarities. There have been, and undoubtedly will be, times when our eyes are simply not good enough. The accident around which this article was written, is one such time.

While we don't know of any 100 per cent foolproof means of preventing all midair collisions, there are many safeguards that undoubtedly have operated to keep the number down. Without listing these, they are contained in the FAR and AIM and Air Force publications. Ignorance of these, like ignorance of the law, is no excuse—it will not save one's life.

All aircraft should be equipped with devices for providing visual contact at a minimum of eight miles. Note the word, *minimum*. Actually, because of the closure rates we live with today, this distance should be greater. Strobe beacons are a great improvement over previous lighting and are much more effective during daylight. Possibly a whole family of collision prevention systems will be available soon.

Air Force pilots are professionals who combine a high degree of knowledge with discipline and ability. The same can be said for airline pilots. General aviation pilots range in ability from optimum to barely proficient. Whether we like it or not, when the Air Force pilot is sharing airspace with them, he must fly as though he were assuming responsibility for both himself and the other fellow. Sometimes, unfortunately, even this is not enough. ★

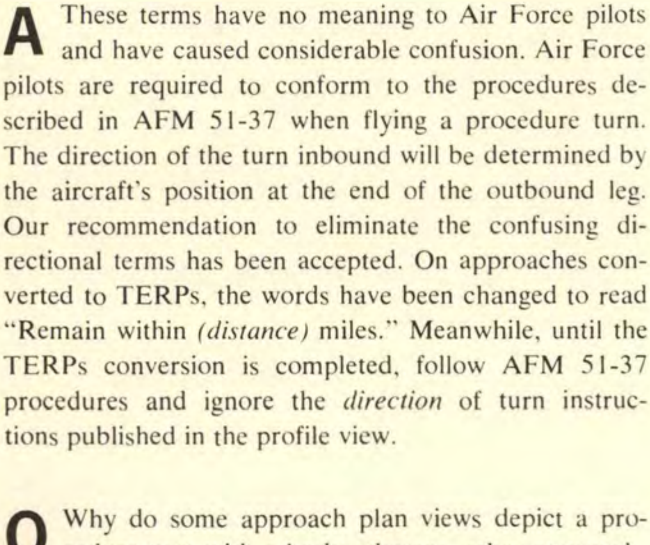
the I.P.I.S. approach

By the USAF Instrument Pilot Instructor School, (ATC)) Randolph AFB, Texas

Q What is the intent of the term "right" or "left within 10 NM" which appears on many procedure turn profile views? If AFM 51-37 procedures are used, the direction of turn inbound will frequently be opposite to the stated "right" or "left."

A These terms have no meaning to Air Force pilots and have caused considerable confusion. Air Force pilots are required to conform to the procedures described in AFM 51-37 when flying a procedure turn. The direction of the turn inbound will be determined by the aircraft's position at the end of the outbound leg. Our recommendation to eliminate the confusing directional terms has been accepted. On approaches converted to TERPs, the words have been changed to read "Remain within *(distance)* miles." Meanwhile, until the TERPs conversion is completed, follow AFM 51-37 procedures and ignore the *direction* of turn instructions published in the profile view.

Q Why do some approach plan views depict a procedure turn with a barb; whereas, other approaches use a teardrop or procedural holding pattern symbol?



A Technically, the barb is the only correct symbol for a procedure turn. The procedural holding pattern and teardrop symbols have been deleted from the approach symbol legends. Unfortunately, many approach designers have not converted to the correct barb symbol. All three symbols indicate exactly the same thing—the depicted procedure turn side. Presently, flying procedures are also the same for all three. However, the use of three symbols (two of which are no longer authorized) to depict the same meaning is extremely confusing. Are the procedure turns at your base correctly depicted with the barb?

NOTE: The next revision to AFM 51-37 will recognize only the barb as the procedure turn symbol. Approach designers, let's use the correct barb symbol if we intend to depict a procedure turn.

Q If outbound course guidance is not available, a pilot must maintain the procedure turn altitude until on course inbound. What constitutes adequate course guidance outbound? and what is the meaning of the AFM 51-37 term "headed inbound?"

A Adequate outbound course guidance is available when an ADF, VOR, or TACAN station is the procedure turn fix. Outbound course guidance is not available when the procedure turn fix is formed by an intersection, OM or DME fix. When course guidance is available, a pilot must ensure his aircraft is headed inbound and is within and will remain within 20 degrees of the inbound course before descending from the procedure turn altitude. An aircraft must not be allowed to exceed the 20 degree segment after starting descent. Pilots should carefully consider the magnitude of turn and the existing wind before electing to descend from the procedure turn altitude. "Heading inbound" means the aircraft heading is within 90 degrees of the inbound course. The intent of these limitations is to provide obstruction clearance as defined by JAFM 55-9, TERPs. Do not start descent until all restrictions are met and can be maintained.

POINT TO PONDER

Our friends in the air traffic control business have asked us to put out the word. If you want to cancel your IFR flight plan, the controller needs a definite statement of this fact. In other words, transmissions such as, "VFR, switching to tower" don't hack it. IFR responsibilities are not terminated until a pilot's formal request to cancel IFR is received. ★

WHAT ARE YOUR INTENTIONS?

Maj Everett E. Ruble
Directorate of Aerospace Safety

When we say what we are thinking, does the message received on the other end mean the same? Does the controller, for example, really understand your problem and exactly what your intentions are?

Communications between crewmembers and ground controllers have at times presented problems, even though many words have been put into regulations, advisories, manuals, and letters on the use of standard radio phraseology. Generally, things work out pretty well even though the correct terminology is not always used. All that matters is that the controller understands our desires and intentions, whether correct phraseology is used or not. Here is an example of what can happen when communication breaks down.

A large jet transport aircraft departing a mid-western base received minor damage when hail was encountered in a thunderstorm. A thorough weather briefing had been received at base weather, and the aircraft commander had studied the weather radarscope noting the location of the thunderstorms in the immediate area before departing on the mission. He determined that the northeast quadrant was clear of any significant weather and decided to climb to cruise altitude in this direction to keep clear of storms. Then he would head west after reaching an altitude that would al-

low him to either top or circumnavigate most of the bumpers. Without a navigator on board to operate the airborne radar, this was a good plan. It was daylight, another crewmember could turn the radar set on, and they would remain VFR while climbing in the clear quadrant to cruise altitude. OK. let's go on this flight.

On the way to the bird, blue sky was observed in the intended departure route. The aircraft radar was checked and found to be satisfactory. ATC clearance was requested and received for an immediate left turn after takeoff to a northeast heading, climb to FL 230 with an altitude restriction of 7000 feet for 10-15 minutes with radar vectors. The pilot made it clear to the tower and departure control that he intended to remain clear of thunderstorms. An immediate turn was made after takeoff with normal acceleration and climb to 7000 feet. Up to this point, the flight was proceeding exactly as planned. Now the misunderstandings that led to the mishap start forming.

Departure control directed a turn to the southeast. This was done and, after rollout, the pilot requested a climb to the northeast, but due to radar range limitations, the controller strongly suggested the southeast vector for the purpose of circumnavigating the weather. The pilot stated that he desired to remain VMC (ICAO terminology for visual meteorological conditions), which was meaningless to the controller. Had the pilot at this point insisted on remaining VFR and had made his intentions clear to the controller, the incident would have been avoided.

The radar vectors and an alternate plan were accepted. Aircraft radar confirmed the presence of heavy weather to the southwest of track with gaps noted between cells. The aircraft was cleared and a climb started to FL 230. They entered the clouds passing 11,000 feet. Now the controller issued a clearance for a turn to a westerly heading but used a wrong call sign and was not acknowledged. As the aircraft overshot the intended track through a gap in the weather, the controller became more urgent with his instructions and, finally, after using the proper call sign, the turn was executed. On completion of the turn the aircraft entered moderate turbulence and the pilot's radarscope became useless due to bleaching, gain or range adjustment, and heavy precipitation. This condition continued until heavy turbulence and hail were encountered and the radome separated from the aircraft. Recognizing possible aircraft structural damage, loss of radome and radar capability, the pilot requested radar vectors back to the departure point. Vectors were given to return through the same gap that the controller attempted to take the aircraft through on departure. Moderate turbulence was experienced on the return flight but no further damage was sustained.

The pilot's intent to avoid clouds was firmly established. However, it was concluded that the mishap would have been prevented provided clear, concise and simple voice communications had been utilized between the departure controller and the aircrew. The request to climb VMC to the northeast was not understood by the controller. He should have obtained the true desires of the aircrew, and the crew should have used standard phraseology. Another point of confusion came after the pilot requested the VMC climb and he received the reply, "I can give you a NE climb, but cannot get you around the north end of my radar." Not knowing the statement was made because of the maximum range of the radar and not because of the severity of the weather, he accepted the controller's vectors.

Lessons learned: One that we have heard many times. Thunderstorms and aircraft are incompatible *—so stay out of those cumulobumpus clouds.* Another is the phraseology used in our communications with the controlling agency: Make sure each understands what is intended and expected — know what you mean, say what you mean and make sure it is understood. ★

A NEW BAK

THE LATEST MODEL ARRESTING GEAR . . . THE BAK-13

Maj David L. Elliott, Directorate of Aerospace Safety

The new improved BAK-13 arresting system comes with many ingredients. It's the latest model. It has a low profile and a rugged hell-bent-for-leather look. It's in the medium price range (costs more than a VW and less than an F-4). It has a suspension system unexcelled in the so-called highly mobile category.

When you first observe this new system, I'm sure you'll agree that it's an all around real fun thing.

This new system is being installed at several selected locations in Southeast Asia now. Some are already in position and successful engagements have been accomplished. Testing on the system has been underway for many months and after some minor modifications—it's ready for action.

The handbook says that the primary purpose of this arresting barrier is to provide operational, rapid cycle recovery of hook-equipped aircraft in an austere forward area environment. Most significant is that word "operational." Until now the arresting barriers have been designed for emergency use, even though in some locations the F-4 use of the BAK-12 arresting system has bordered on operational utilization. The big advantage of the BAK-13 is that it can take repeated rapid cycle engagements. This system could facilitate an arrestment every three minutes or 20 engagements in one hour.

It looks a little like a BAK-12 with the tape reel lying on its side rather than vertically. It has a pendant and a tape and reel on each side of the runway like the BAK-12,

but from there on the system is different, although not unique.

The system uses the principle of twisting water to absorb energy. The tape reel is on its side to simplify construction of the system and to provide a low profile. A water turbine rotor is connected directly to the reel shaft. The turbine assembly consists of the rotor containing a double row of nine vanes. This rotor is mounted in a liquid-filled stator housing equipped with two sets of eight vanes. Since the rotor and reel assemblies are connected on a common shaft, they are rotated together during an engagement as the tape is pulled off the reel. This hydraulic interaction between the rotor and the stator vanes provides the retarding force. It's sort of like the opposite of a fluid drive—the end product is a fluid stop.

If it sounds complicated, it's the theory, not the equipment. Except for the rewind system, we've just discussed the entire arresting system. The water twister is an energy absorbing water brake of simple, maintenance-free design and construction.

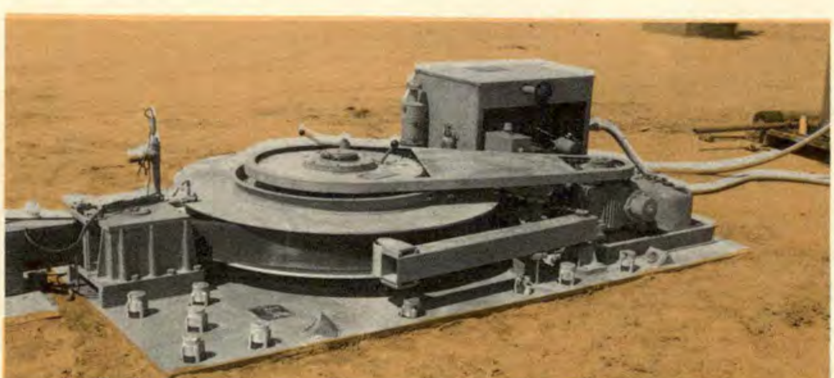
The theory is really not complicated. Water twisters operate on the principle of converting the kinetic energy of fluid turbulence and motion to heat energy. The fluid used is a mixture of ethylene glycol and water.

In the BAK-13, the heat generated by an engagement is dissipated by an auxiliary heat exchanging system. This system consists of a pump and a water tank. The pump circulates the water during the rewind cycle. This system also makes sure the rotor housing is fully serviced following each engagement.

When the tailhook engages the pendant (cable) the reel pays out the nylon webbing—the webbing rotates the water brake. The webbing is wound around the reel, layer on layer. As the aircraft slows down, the tape being played out decreases the radius of the webbing on the reel and maintains the rotational velocity of the water brake. This results in an efficient energy absorption curve (at design weight).

The following charts are derived from preliminary data. Normally we don't release preliminary data, but since the system is becoming operational and the engineers referred to this data as "High Confidence Preliminary Data" it's presented for your information. Limits are based on a 190 foot span and would be slightly different for other runway spans.

Data analysis has not progressed to the point where readout charts for the F-4 can be provided; however, all tests so far indicate that the BAK-13 is fully compatible with the F-4, being limited only by the barrier kinetic energy limit — 180 knots at 57,000 lbs. and 190 knots at 52,000 lbs. ★



F-111*

Acft. Wt.	Limit Speed
90,000	146
85,000	150
80,000	155
75,000	161
70,000	166
65,000	171
60,000	175
55,000	178

*(Kinetic Energy Limits of BAK-13)

F-100 MAXIMUM ENGAGING SPEEDS

CHART A Hook Design Limit Strength = 84,000 Lb.		CHART B Hook Yield Strength = 96,500 Lb.	
Acft. Wt.	Limit Speed	Acft. Wt.	Limit Speed
24,000	181	24,000	190
26,000	178	26,000	188
28,000	175	28,000	185
30,000	172	30,000	183
32,000	170	32,000	181
34,000	167	34,000	179
36,000	165	36,000	177
38,000	163	38,000	175
40,000	161	40,000	173
42,000	159	42,000	172

F-101 MAXIMUM ENGAGING SPEEDS

CHART A Hook Design Limit Strength = 67,000 Lb.		CHART B Hook Yield Strength = 77,000 Lb.	
Acft. Wt.	Limit Speed	Acft. Wt.	Limit Speed
30,000	152	30,000	164
32,000	150	32,000	162
34,000	148	34,000	159
36,000	146	36,000	157
38,000	144	38,000	156
40,000	142	40,000	154
42,000	141	42,000	152
44,000	139	44,000	150
46,000	138	46,000	149
48,000	137	48,000	149
50,000	137	50.000	148
52,000	136	52,000	147

F-102 MAXIMUM ENGAGING SPEEDS

CHART A Hook Design Limit Strength = 47,000 Lb.		CHART B Hook Yield Strength = 54,000 Lb.	
Acft. Wt.	Limit Speed	Acft. Wt.	Limit Speed
20,000	137	20,000	148
22,000	134	22,000	145
24,000	131	24,000	142
26,000	129	26,000	139
28,000	127	28,000	137
30,000	124	30,000	135
32,000	122	32,000	133

F-104 MAXIMUM ENGAGING SPEEDS

CHART A Hook Design Limit Strength = 60,000 Lb.		CHART B Hook Yield Strength = 69,000 Lb.	
Acft. Wt.	Limit Speed	Acft. Wt.	Limit Speed
14,000	165	14,000	173
16,000	162	16,000	171
18,000	159	18,000	168
20,000	156	20,000	166
22,000	153	22,000	164
24,000	150	24,000	162
26,000	148	26,000	158
28,000	145	28,000	157

Data for the F-105 is not yet available. According to SMAMA, the information will be disseminated to users as expeditiously as possible.

F-106 MAXIMUM ENGAGING SPEEDS

CHART A Hook Design Limit Strength = 54,800 Lb.		CHART B Hook Yield Strength = 63,000 Lb.	
Acft. Wt.	Limit Speed	Acft. Wt.	Limit Speed
26,000	140	26,000	152
28,000	138	28,000	149
30,000	136	30,000	147
32,000	134	32,000	145
34,000	131	34,000	143
36,000	130	36,000	141
38,000	128	38,000	139
40,000	127	40,000	137
42,000	125	42,000	136

A well seasoned crew with long experience in the aircraft and the base, coupled with a daylight takeoff in excellent weather; all the ingredients for a ho-hum flight. How ironical that these same conditions can also bear the seeds of....

A Dreadful Disease

Maj James A. Whitener, Directorate of Aerospace Safety

Flying safety officers have been preaching for years that accidents don't just happen—they are caused. Analyses of accident files will prove that most accidents are the result of several causes. The first clue may be minute, but if not properly corrected can develop into a "stark terror" situation. This development can be a drawn out process, or it can reach full bloom in a matter of seconds.

Regardless of the time element involved, aircrews must be prepared for the unexpected, thoroughly trained in procedures, and function as a team if corrective action is to be effective. If these requirements are not met, the results can be disastrous. The following flight narrative illustrates this point.

A C-47, locally known as the hangar queen, had not flown for two and one-half months due to excessive canibalization. After Maintenance had completed the last major repairs, replacement of the Nr 1 engine and both propellers, the aircraft was scheduled for a functional check flight. It was serviced with two hundred gallons of fuel in each auxiliary tank (approximately 30 gallons remained in the left main and 40 gallons in the right main from the previous flight).

During the morning prior to the check flight, the flight mechanic washed the aircraft. While taxiing back from the wash rack, he performed an engine runup and all systems checked to his satisfaction. When the pilot and copilot reported to the aircraft, the pilot was briefed by a representative from Quality Control that the functional check flight was for an engine change and two propeller changes.

After conducting a walk-around inspection, the pilot, copilot, instructor flight mechanic and student mechanic boarded the aircraft. Engine start and taxi to runup position were uneventful. While the aircraft was being taxied to the runup area, the flight mechanic reviewed Dash One emergency procedures with the student mechanic in the galley. During runup, the pilot asked the flight mechanic how much fuel was on board, because the right auxiliary fuel gage indicated only 90 gallons. The mechanic replied that 400 gallons were in the auxiliary tanks and that the gage was out of calibration. He made no mention of the fuel in the main tanks because he wanted the pilot to operate the engines on the auxiliary tanks. Other than an initial slightly high oil pressure reading on the Nr 1 engine, which corrected itself after the props were exercised, all systems checked normal.

The crew completed engine runup and the Before Takeoff Checklist, but the takeoff was delayed due to an aircraft on final approach. The pilot briefed that, in case of an emergency, he would fly the airplane and the copilot should handle the emergency in coordination with the flight mechanic. Due to the delay, the mixtures were placed in the autolean position, cowl flaps opened, and booster pumps turned off. When the landing aircraft cleared the runway, the C-47 was cleared for takeoff, and the Before Takeoff Checklist and the Line-up Checklist were reaccomplished. Power was applied and the aircraft lifted off at 85 knots.

After establishing a climb attitude and accelerating to approximately 95 knots, the pilot called, "Gear up." As the copilot, who continued to monitor the engine instruments, reached for the gear handle, the flight mechanic reported fuel pressure was dropping on the Nr 1 engine. The pilot then felt the aircraft yaw to the left and called, "We have lost the Number One engine." Estimated altitude at this time was

50 to 75 feet and the airspeed 95 to 100 knots. "Is the gear up or down?" the pilot asked. He never received a reply.

The copilot *assumed* that the pilot would land on the remaining 8000 feet of runway and left the gear down. *Assuming* the gear was coming up, the pilot elected to continue the takeoff. He pushed the Nr 1 feather button and called, "Max power on Number Two engine." But unknown to the pilot, the Nr 1 prop did not completely feather. The drag created by the windmilling prop and the extended landing gear was enough to cause the aircraft to settle back to the runway in a tail first, right wing low attitude, 6500 feet from the takeoff end.

The aircraft bounced back into the air and started a left turn. With maximum power applied to the Nr 2 engine, the pilot was unable to correct the left turn, even with full travel of the right aileron and right rudder. Nevertheless, the takeoff attempt was continued.

The aircraft flew approximately 1000 feet, then made a series of bounces across some drainage ditches and finally impacted, with power still on the Nr 2 engine, at a point 8200 feet from the takeoff end and 800 feet left of the runway centerline.

Path of aircraft after left engine failed. Fortunately, crew escaped but the aircraft was destroyed. Complacency, poor crew coordination again prevailed.

When the aircraft bounced off the runway and it became obvious that it was going to crash, the flight mechanic evacuated his position between the pilots' seats and went to the main cabin area to brace himself for the impact. The student flight mechanic was already in the rear for the purpose of making an engine and over-wing check after takeoff. He felt the aircraft yaw to the left and saw the ground coming up so he stayed in the main cabin and braced himself for the crash. After the aircraft came to a halt, the flight mechanics opened the entrance door and left the aircraft followed by the pilots. When the fire trucks arrived, a fireman and the student flight mechanic re-entered the aircraft to turn off the fuel selectors and battery switch. The pilot had turned off the ignition and placed the mixture controls to idle cutoff. None of the crew, except the pilot, who suffered a minor cut, was injured. The aircraft was destroyed.

Although the pilot had briefed that the takeoff would be made on the auxiliary tanks and later testified that the engine runup and takeoff had been accomplished with the fuel selectors in that position, post accident investigation revealed the left main tank was dry and the left auxiliary tank full. The Nr 1 engine failed due to fuel starvation. In addition to this finding, the accident board listed several other findings that indicated poor supervision, flight planning, crew coordination and crew discipline. Following are some examples.

- Flight orders for the crew were not properly prepared.
- The pilot did not have a current instrument rating.
- The checklist used by the crew was three years out of date. Five important items were missing from the Before Takeoff Checklist: (1) Cowl flaps—trail CP; (2) Carburetor air ram/climatic CP, P. CAUTION: The use of carburetor heat requires constant monitoring to preclude excessive CAT limits; (3) Mixture controls — auto rich — P; (4) Propeller controls — full increase — P; and (5) Trim as required — P.
- A weight and balance was not computed for the flight, a canned Form F was not on file in base operations or in the maintenance section. The pilots assumed that the CG and the aircraft weight were the same as for other aircraft in the fleet.
- A TOLD Card was not computed although required by the Dash One. Takeoff and climb speeds were assumed by the pilot based on aircraft familiarity.
- All crewmembers were not fully aware of the reason for the check flight. The pilot was briefed by a Quality Control representative that the Nr 1 engine and both props had been changed; the copilot thought both engines had been changed; the instructor flight mechanic had worked on the aircraft and knew which components had been changed; and the student flight mechanic wasn't certain which components had been changed.
- The copilot did not retract the landing gear when ordered to do so by the pilot, nor did he complete any of the bold face emergency checklist items as briefed by the pilot after the Nr 1 engine failed.

Both pilots had in excess of 4000 hours flying time. After reading this, your first thought probably is, "How could all this happen?" This accident once again proves that complacency is a feared and dreadful disease. Don't let it infect you or your organization! ★

REX RILEY'S CROSS COUNTRY NOTES

THE WARNING FROM TOWER, "Watch out for jet wash from departing aircraft" is becoming familiar to all pilots who transit busy airports. A recent incident at a large west coast facility points out another danger created by the big jets at the same time they are churning up turbulence.

A T-39 was cleared to take off behind a Boeing 707 airliner. Because of heavy traffic, the tower asked the sabreliner to expedite. On the initial run the little bird ran into a cloud of debris blown up by the big fellow and rocks cracked the left windshield. The T-39 pilot suspected that there was also foreign object damage to the left engine, but this was discovered too late to effect an abort. Landing was made at an intermediate base to inspect the damage. FOD had taken its toll and the engine was replaced. Keep your distance behind the big ones!

HOW DO YOU MEASURE YOUR MECHANICS? This word from TAC Headquarters is well worth contemplating:

"Accident investigators found in the twisted tangle of what had been an F-100 a reason for sudden engine seizure: A small, engine-oil sample bottle finally worked its way into the 'aircraft-accident position.' Inverted, it had sealed off the oil tank return line to the engine. Loss of lubrication followed. As a result, a dime's worth of bottle needlessly endangered a fighter pilot's life and destroyed part of TAC's combat capability—plus, a large measure of respect for an unidentified maintenance man.

"Ironically, the normal purpose of the Spectrometric Oil Analysis Program is to save lives and aircraft. And when used 'as advertised' it does just that.

"How did it get 180 degrees out of phase and produce, rather than predict, engine failure? Simply by one man's unwillingness to admit his understandable error when he dropped the bottle during oil sample removal! It would've been easiest then, but his pride meant more at the moment than the delayed-action accident he initiated. And the longer he delayed, the more difficult its admission became.

"How do you measure a maintenance man? In the airplane-driving business you admire that exceptional ground crewman who always does his job right. But, you also reserve a great deal of respect for the man who admits to serious error—and he gains stature in the process."

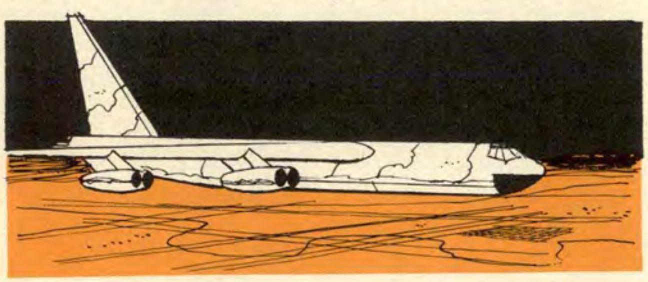
And that goes for your own profession, trade or specialty when the lives of others depend upon your skill and integrity.

SEVERAL PILOTS were forced to bail out in an arctic region recently. Survival equipment training paid off handsomely when all successful rescues were enhanced by use of RT-10 and URC-11 survival radios, Mark-13 flares and pen gun flares. One of the pilots started a fire with matches and sheets of AFM 64-5 from his MD-4 survival kit.

Winter is still with us and all aspects of emergency training are particularly important. Learn and re-learn; practice and re-practice because you never know when you will have to recall some effective method to help rescuers find you. Tips like using the colored smoke in the day end of the Mark-13 flare to stain snow, while at the same time using it to attract attention, assume vital importance. Learn your emergency procedures so well that you will remember to save the other end of the day/night flare you have just used in case you need it later. Don't pass up any opportunity to refresh your survival techniques.

FREQUENCY DISCIPLINE is becoming more important every day, as use of our airspace continues to increase. The Strategic Air Command put out the following "word" to its crewmembers:

". . . Most air traffic control (ATC) frequencies are simplex, meaning that both the facility and the pilot transmit and receive on the same frequency. This has often been referred to as a 'party telephone line.' Simply stated, when one party is transmitting on the frequency, it should not be used by another party. Excessive and unnecessary transmissions by a pilot interfere not only with the normal operational routine, but they can also create a hazard by blocking an emergency transmission from the facility or another pilot. This can be particularly critical at radar locations



where radar vectors are provided to separate and sequence aircraft and vectoring airspace is limited. To reduce frequency congestion please abide by the following:

• Be aware of the need for frequency discipline.

• Be aware of and tuned to the proper frequency to use for the specific ATC function being provided.

• Listen before talking. There could be emergency transmissions on the frequency you intend to use. Also, listening will often provide you with information you need if you intercept a controller's transmission to another aircraft; i.e., wind direction, velocity, runway in use, altimeter setting, weather, etc. (When you have intercepted this type of transmission, be sure to tell the controller you 'have the numbers' or use a similar term.)

• Say what needs to be said in conducting or planning your flight only to the extent that it is clear to both you and the controller what you want or need to do.

• Remember, when talking on a simplex frequency, you cannot hear on that frequency.

• As a cardinal rule, keep the frequency to be used available for use by everyone to the maximum extent possible."

Let's all heed this advice and reduce the "din" to a tolerable level.

THE JET TANKER RECEIVED clearance and started a penetration to a large midwestern base. Approach Control advised the pilot of moderate moving traffic; he replied that IFR conditions prevented visual identification of the targets. About halfway through the penetration there was a break in the clouds and the tanker pilot spotted a large prop transport directly in front and below, precisely in the center of his final approach path. Immediate evasive action was necessary to avoid a collision. This incident should serve as a warning that all aircrews must maintain a constant vigil when weather conditions permit, no matter how short the period.

On the day before, a fighter crew climbing out of a western base suddenly observed a civil aircraft slightly to their right and above. It was a glider and its pilot had taken evasive action to avoid the F-4. The glider pilot had seen the fighter early enough to keep out of its way, but the F-4 did not have time to give way to the glider. Hairy? You bet, and it is going to get worse before it gets better! ★

stress corrosion cracking ...WHY?

Dwight W. Johnson, Directorate of Aerospace Safety

Stress corrosion cracking of high strength alloys is a major cause of primary structure failure in Air Force systems. Current weapon systems of all types — bombers, fighters, ballistic missiles — have been plagued with such failures and costly retrofit programs. Why? Is it because of severe environmental conditions? Overload or abuse? A mysterious attack? Not exactly.

Although the mechanism of stress corrosion is not fully understood, major features are well known and common to most alloys. The problem has been to keep apart the necessary ingredients for ultimate failure. But they are close at hand during the journey from the designer to the operational system, so it doesn't take much of a slip-up to bring them all together.

Let's examine the problem—what stress corrosion is, the factors involved, how stress corrosion cracking comes about in service in spite of our knowledge, and what is or can be done to prevent recurrence.

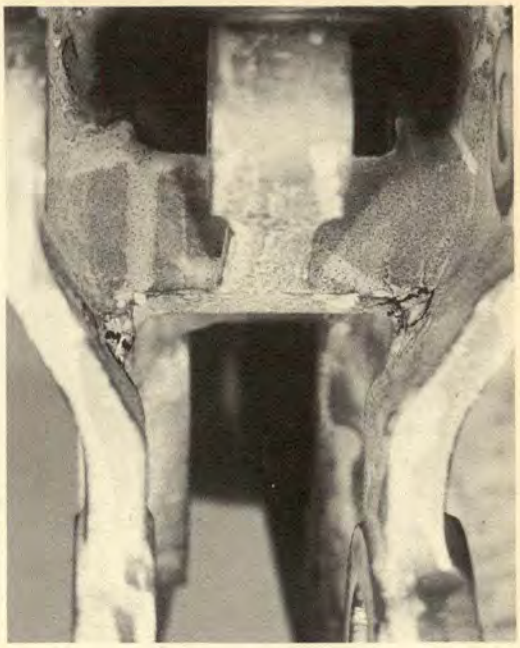
Stress corrosion is a complex interaction of sustained surface tension stress and corrosive attack resulting in cracking and premature brittle failure of a normally ductile material. It's the combined effect of stress and corrosion and it doesn't take much of a constant pull to cause failure. Stress corrosion affects many metal alloys but pure metals generally are not susceptible; it is the impurities of alloying components that establish paths along which cracks may develop. The actual mechanism appears to combine electrochemical action with stress sorption.

In the electrochemical theory, galvanic action occurs between local anodic (positive) areas and the more cathodic (negative) areas of the metal surface. With the formation of corrosion tunnels plus high stress acting to pull the metal apart, cracks develop. In nonsimilar metal alloys the cracks follow grain boundaries, which act as anodes with the grains acting as cathodes. In the stress sorption theory, certain ions from the atmosphere are absorbed along the walls and in the tips of cracks, lowering the binding energy between surface atoms to the extent that the cracks grow.

Enough theory—let's look at the known factors involved. Before stress corrosion can occur there must be a proper combination of a corrosive environment, material susceptibility, and stress. All are related to each other and to time (the more severe the environment or more susceptible the material, the less stress required for a given time). And all are known or identifiable. How, then, does a proper combination get together? The usual failure case history includes these salient points: The normal service environment corrosively attacks a stress corrosion susceptible material under an overlooked surface tension stress across a short transverse grain structure.

The term corrosive environment, although technically correct, can be misleading to the designer in that it implies a more severe condition than normal. This is not true. Any atmosphere that will support life will support corrosion. In fact, *any* atmosphere will support corrosion; some are just worse than others. Protective coatings to exclude the environment may appear promising to a designer looking for a "crutch" when a susceptible material is chosen but often are not a practical cure, only a delay. For one thing, a perfect coating is required and then it must be maintained in service—a difficult task to rely on. Only the slightest corrosion is necessary to start the chain of events. Then failure will just be a matter of time. A corrosive environment should be considered unavoidable.

The time required for failure depends on the severity of the other factors. With everything working together, it may be only a matter of minutes. Conversely, years can go by with no failure but followed by an epidemic. Some alloys need an incubation period and become more susceptible with age. Seldom, if ever, does an "isolated" failure occur from stress corrosion cracking. The "first of a kind" is a forewarning of things to come. You can count on it. Corrective action should not await a trend.



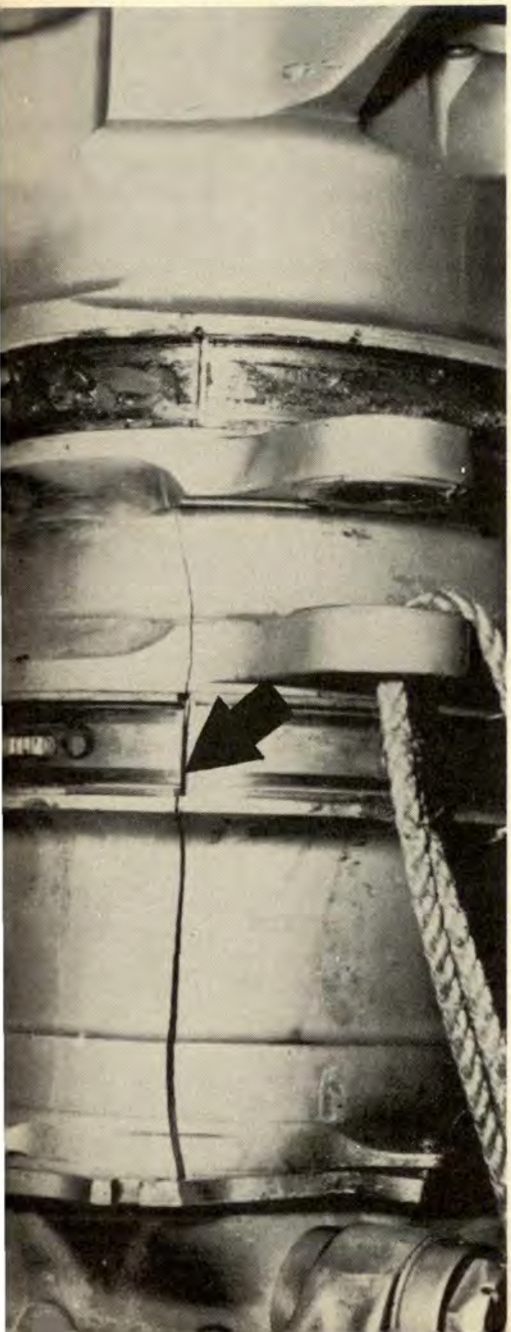
This is not a figure from the Rorschach test, but is a picture of a part sawed to reveal the results of corrosion.

The most effective measure that can be taken to avoid stress corrosion cracking is the selection of a resistant material. All high strength alloys are susceptible to stress corrosion cracking since this is characteristic of the constituents that make them strong. This susceptibility can be reduced considerably by temper but not without some loss in other desired properties. In one aluminum alloy (7075), in the T6 temper favored by aerospace design engineers, an overaging heat treatment (−T73) will increase the minimum stress required for stress corrosion cracking many times — from less than 10 to 75 per cent of its yield strength — but discourages the designer with an accompanying decrease in mechanical properties of six to 10 per cent. Likewise the 17-4PH, H-900 high strength steel extensively used in the aerospace industry can have stress corrosion resistance greatly improved (but with some reduction in strength) by aging at 1025°, rather than 900°F.

The designer naturally favors the highest strength-to-weight ratio material available for aircraft and missile use. It's directly related to the objectives of high performance and pay-load. His chief concern is to provide structural integrity based on specific service loads which are usually intermittent in nature and, therefore, not a stress corrosion factor. If no enduring surface tension is foreseen, a susceptible alloy and temper from a stress corrosion standpoint will be the logical choice.

If a stress corrosion resistant alloy and temper are not chosen, preventing stress corrosion failures requires identification and control of surface tension stresses, residual or applied, that act continuously, especially in a short transverse grain flow direction. This may seem simple—just keep damaging sustained tensile stress away from the surface. But in actual practice, the fabrication and assembly techniques, and subsequent modifications, can raise havoc with the designer's good intentions. The threshold stress below which failure will not occur in a practical length of time varies greatly with the grain structure established by the metal flow during forming. Endurance is much less when pulling across the grain than when pulling with the grain. As mentioned before, stress required in some materials may be less than 10 per cent of the design strength when applied across the grain in the short transverse direction. (The transverse directions are perpendicular to the grain flow with the short transverse usually parallel to the thickness.) Resistance to stress corrosion cracking in the long transverse and longitudinal direction is much higher.

Stress corrosion caused this crack in landing gear strut.



Thin materials seldom have stress corrosion cracking because surface tension normally is not present in the short transverse direction. In forgings it is quite easy to induce high sustained surface tension in an adverse direction, since the grain flow may be complicated and difficult to determine. Surprisingly, however, many service failures have occurred at a location where trouble should be anticipated—the die forging parting plane where metal can be squeezed out as the forging die is closed, and the grain flow is perpendicular to the surface. Other critical locations, where the residual tension stresses may develop on the surface during the temper process, are blind bores, holes, and other shrouded areas.

Residual stresses are inherent to all high strength alloys because of their heat treatment. Normally the tensile stresses are inside with balancing compressive stresses at the surface providing an armor against stress corrosion. The most common practice contributing to stress corrosion problems is that of removing the protective compressive layer at the surface by machining and thereby exposing the residual tension stresses. This can be guarded against to some extent in critical locations by rough machining prior to heat treatment. If not, shot peening or rolling to provide a compressive layer should be accomplished. The trouble is, the man authorizing the machining may not realize the criticality of his action. Other often forgotten or neglected sources of surface tension stresses are those occurring during assembly as caused by interference fits, clamping and tightening. Forcing of the mismatches is seldom, if ever, provided for in stress considerations.

The key to preventing stress corrosion cracking is awareness — awareness from design through fabrication, assembly, installation, and any eventual modification. The problem is not lack of knowledge but lack of application of this knowledge.

A red flag should be raised as soon as a "susceptible" material is chosen. If potential trouble is recognized along the processing route, compensating changes can be made —stresses may be controlled, grain flow may be controlled, the machining heat treat sequence may be modified, surface residual tension stresses can be buried, and, where necessary, the temper can be altered. Why not sacrifice a few per cent in strength/weight ratio for a manyfold increase in stress corrosion resistance of components that are critical or in hard-to-get-at locations? In any event, someone with a caustic eye should watch over the whole proceedings.

Awareness of the stress corrosion cracking problem is being emphasized in current USAF Design Handbooks. Requirements on forgings include destructive analyses to determine grain structure and the direction and magnitude of stress; limiting the applied and residual surface tensile stress in relation to grain flow direction; avoiding stress concentrations and assembly stresses; and employing methods to insure that final machining surfaces are in compression. A close watch will be kept on the two approaches contractors may take—use of materials highly resistant to stress corrosion with an accompanying small weight penalty; or use of susceptible material with reliance on the control of tensile stresses. Regardless of which approach is taken, future weapon systems should be much more immune to stress corrosion cracking than are present systems. ★

BIRD CONTROL

Elwood A. Seaman
Assistant for Natural Resources, IG, USAF

For the past two years at seven U.S. Air Force bases, a relatively new product has been used for the control of certain species of birds considered as hazards to aircraft. This is a brief report to evaluate the effectiveness of the product, *Avitrol 200*. It does not represent research. To the contrary, this information was compiled from reports from bases where *Avitrol* was applied as directed by the producer, Phillips Petroleum Co.

Bird/aircraft strikes at USAF bases are increasing each year. The problem is of such serious nature that it becomes essential to control certain species of birds at airfields. In 1967 there were 379 reports of USAF collisions with birds. Two major accidents cost $740,000. It is estimated that the cost of repair and replacement runs well over 10 million dollars per year. One pilot fatality occurred due to a bird strike in 1967.

Use of *Avitrol* is but one bird control method employed by the Air Force. Falcons, shellcracker noise makers, bird distress cry recordings, auto vehicle disturbance, habitat alteration are other methods.

Avitrol's use is through both federal and state permits since many species of birds are protected by law. The product is poisonous; therefore, it is used by personnel trained in handling such products. *Avitrol* is effective primarily on flocking birds. For the product to be useful, it is necessary to get some of the flock to eat small doses, which produces incoordination and narcosis, so that the affected birds give out distress cries and this reaction usually alarms the balance of the flock.

The product is sold in several different forms dependent upon the species of bird for which it is to be used for control. It can be purchased premixed with grain for control of feral pigeons, English Sparrows, cowbirds, and certain blackbirds. It is also available in powdered concentrate for mixing with squares of bread for gull control.

The accompanying chart provides limited data on the use of *Avitrol* at seven Air Force installations. Of the seven bases five are on or very near saltwater coasts, two are inland and not adjacent to water.

All seven bases are continuing use of the product for bird control at airfields. Evaluation viewpoints are those of entomologists, pest control operators, and civil engineers who have supervised use of the product. ★

EVALUATION OF USE OF AVITROL 200

AF Base	Bird Species Affected	Success of Application	Effective Length of Application	Remarks
Patrick AFB, Florida	gulls (Ringbilled, Herring, Laughing)	Entire year, very good	One month or more each application	This control method was so effective that use of shellcracker scaring was discontinued. Garbage landfill source of gulls, as well as coastal waters.
Kirtland AFB, New Mexico	crows, starlings, ravens, English Sparrows	Very good		Only species which returned were sparrows.
MacDill AFB, Florida	gulls (Herring, Laughing)	90-95% effective on gulls	Two months	Effectiveness is greater with large flocks. This was a detailed study.
Lockbourne AFB, Ohio	starlings, pigeons, sparrows	Good results	Two to three weeks	Despite limited study effectiveness well demonstrated.
Eglin AFB, Florida	gulls	Very effective	30 days (Ten Feedings)	Useful only when used in strict accordance with instructions. Bait shyness may take place after ten feedings. Suggest other methods of sea gull control be used in conjunction with Avitrol to obtain maximum effectiveness. (Such as sound scare devices) Is at best a temporary deterrent, worth its cost.
Langley AFB, Virginia	gulls	Very effective	"Several days"	Cost of product negligible as related to results obtained, especially if it has prevented a serious aircraft accident.
Myrtle Beach AFB, South Carolina	gulls	Very effective	One to seven days	Effective only if little rainfall.

taking the option

Lt Col Karl K. Dittmer
Directorate of Aerospace Safety

I appreciate good, smooth, coordinated flying as much as anyone, and the young man in the front seat of our Wichita Wonder was as smooth and coordinated as the best. Nice precise turns, altitude right on the button—beautiful. Too bad we were flying over South Vietnam where Charlie is the one who best appreciates such qualities. My own efforts with stick and rudder in that area would make a flight instructor up-chuck, but they also made the little O-1 a rather lousy target for Charlie.

Here in the land of the free, I have again become reasonably coordinated. But some can find fault with my precision in the lower altitudes. Take my last T-39 proficiency check. After completing all the required items I traded seats with another pilot who needed a recurrency check. Back on the ground the examiner pointed out my shortcomings — airspeed varied up to 15 knots during climbout and wasn't much better during descent and in the traffic pattern. Heading wandered 10 degrees or so during the same phases of flight. Altitude was within 100 feet which he reluctantly accepted as within tolerance.

"You figure I'm not safe?"

"Oh, you're safe enough; it's just that you should be more precise."

True, and I will strive to be more accurate, but without decreasing my scan outside the cockpit. On this same flight, I couldn't help notice that when the other pilot flew his portion of the mission he flew through one of the nation's most crowded sections of air space at 6000 feet with BOTH pilots paying almost full attention to instruments. Visibility was about five to 10 miles and although we were on an IFR clearance, many other pilots were not.

Two or three years ago I was scheduled to transport a couple of passengers across the country by T-39. As usual, I did my flight planning, filed a clearance, and arrived at the bird well ahead of time. The bird was ready, the passengers were ready and eager to get going since they'd miscalculated time zones and would be arriving later than desired. Without rushing things, the other pilot and I preflighted and managed to get airborne about 20 minutes before our scheduled takeoff time. We were criticized when we got back. I explained the situation and was told to make good the scheduled time in the future, regardless. A small item, but indicative of a larger problem—the same problem that caused the check pilot to put more emphasis on precision than on looking for traffic . . . and influenced the precise O-1 pilot. These people have become slaves to the system. They've turned off reason and seem to blindly believe what is good for one area of flight is good for all areas.

I saw other examples of this in

Southeast Asia. Fighter pilots who set up a gunnery range type pattern to attack ground targets. Forward air controllers who insisted attack aircraft make all runs from the same direction when there was no valid reason. This may make it easier for the controller to keep tab on the situation, and the gunnery range pattern may provide more consistent bomb runs with slightly better accuracy. But it's a good way to pick up combat damage. The fighter pilot doesn't have to slop around the sky with the ball all bent out of shape to spoil Charlie's gunnery problem. In fact, he should do everything he can to fly a well coordinated, accurate, delivery run. He'll have to fly more missions against the same target if he misses. But with just a little practice, he can mix up his attack headings and still have accurate runs. Also, unless the FAC has some definite and valid objection, the flight can mix up their delivery techniques so Charlie doesn't get a chance to zero in on the low level birds. There are other ways to help cut losses—like having one aircraft strafe to make 'em duck while a second aircraft comes in with CBU or other low level stuff.

All of this is basic, but it's based on lessons we learned in World War II (more accurately, RElearned, but I didn't get hatched in time for the first big war). We relearned a lot of this basic stuff in Korea and we're going through the same expensive re-education process with each batch of new troops entering the current conflict.

I have one final example. This one started some years back when the impatient commander of a four engine bird failed an attempted three engine takeoff. I don't recall just how closely he pushed the aircraft's capability. But, he obviously exceeded his and the bird's combined capabilities, because he bashed. And, I do recall that the only reason for attempting the takeoff was because the crew wanted to get home for the holiday season.

Some command directives on three engine takeoffs came out as a result of this accident and now all pilots must get prior approval. More recently a news release told about a field grade officer who unstrapped from his four engine bird to rush over to a command post so he could phone in a request to make a three-engine takeoff. His aircraft had just finished offloading cargo and the crew couldn't get one engine to crank up. This would have been OK except for one thing. The bird was the center of interest for an enemy mortar attack at the time!

How inflexible can you get? This story saddened me because flexibility is man's chief advantage over his computers, and I suspect is the reason most regulations give the pilot in command the prerogative to deviate when, in his judgment, a deviation is in the interest of safety. ★

the CAT PRIMER

The following is one of the most concise reports we've seen on Clear Air Turbulence. We picked it up from Air Canada's *Grapevine*. They got it from the report of the third meeting of the IATA meteorological subcommittee, Estoril, Portugal, June 24-28, 1968, an IATA working paper to be submitted to ICAO.

• Jet streams stronger than 110 knots (at the core) are apt to have areas of significant turbulence near them in the sloping tropopause above the core, in the jet stream front below the core, and on the low-pressure side of the core. In these areas there are frequently strong wind shears.

• Wind shear and its accompanying clear air turbulence in jet streams is more intense above and to the lee of mountain ranges. For this reason, clear air turbulence should be anticipated whenever the flight path traverses a strong jet stream in the vicinity of mountainous terrain.

• On charts for standard isobaric surfaces, such as 300 millibars, if 20-knot isotachs are spaced closer together than 60 nautical miles there is sufficient horizontal shear for CAT. This area is normally on the north (low-pressure) side of the jet stream axis, but in unusual cases may occur on the south side.

• Vertical shear is also related to turbulence. From the winds-aloft charts or reports, compute the vertical shear in knots-per-thousand feet. If it is greater than five knots-per-thousand feet, turbulence is likely. Since vertical shear is related to horizontal temperature gradient, the spacing of isotherms on an upper air chart is significant. If the 5°C isotherms are closer together than two degrees of latitude (120 nautical miles), there is usually sufficient vertical shear for turbulence.

• Curving jet streams are more apt to have turbulent edges than straight ones, especially jet streams which curve around a deep pressure trough.

• Wind - shift areas associated with pressure troughs are frequently turbulent. The sharpness of the wind shift is the important factor. Also, pressure ridge lines sometimes have rough air.

• In an area where significant clear air turbulence has been reported or is forecast, it is suggested that the pilot begin to slow the air-

craft to turbulence-penetration speed on encountering the first ripple, since the intensity of such turbulence may build up rapidly. In areas where moderate or severe CAT is expected, it is desirable to slow the aircraft prior to the turbulence encounter.

• If jet stream turbulence is encountered with direct tailwinds or headwinds, a change of flight level or course should be initiated since these turbulent areas are elongated with the wind, and are shallow and narrow. A turn to the right places the aircraft in more favorable winds. If a turn is not feasible due to airway restrictions, a climb or descent to the next flight level will usually find smoother air.

• If jet stream turbulence is encountered in a crosswind, it is not so important to change course or flight level since the rough areas are narrow across the wind. However, if it is desired to traverse the clear air turbulence area more quickly, either climb or descend after watching the temperature gage for a minute or two. If temperature is rising, climb; if temperature is falling, descend. Application of these rules will prevent following the sloping tropopause or frontal surface and staying in the turbulent area. If the temperature remains constant, the flight is probably close to the level of the core, in which case either climb or descend as convenient.

• If turbulence is encountered in an abrupt wind shift associated with a chart pressure trough line, establish a course across the trough rather than parallel to it. A change in flight level is not so likely to alleviate the bumpiness as in jet stream turbulence.

• If turbulence is expected because of penetration of a sloping tropopause, watch the temperature gage. The point of coldest temperature along the flight path will be the tropopause penetration. Turbulence will be most pronounced in the temperature - change zone on the stratospheric side of the sloping tropopause.

• Both vertical and horizontal wind shear are, of course, greatly intensified in mountain wave conditions. Therefore, when the flight path traverses a mountain-wave type of flow, it is desirable to fly at turbulence-penetration speed and avoid flight over areas where the terrain drops abruptly, even though there may be no lenticular clouds to identify the condition. ★

ACE

"Show me an aircraft accident and I'll show you one just like it that occurred two years ago, five years ago, twenty years ago."

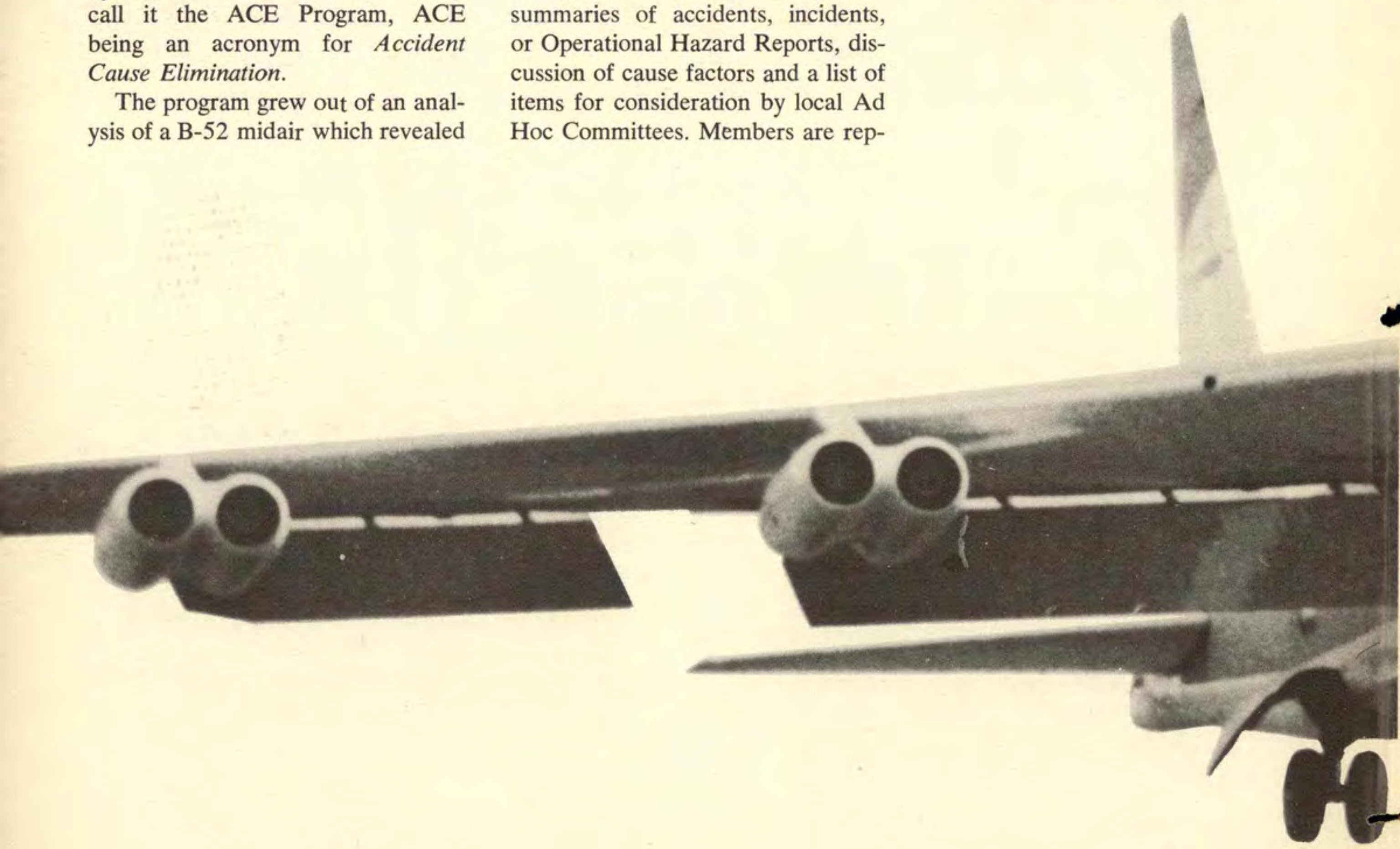
No doubt you've heard statements like this many times. The sad thing is, the speaker is always right. There just aren't any *new* accident causes. On the one hand this is discouraging — we keep dinging airplanes in the same old ways. But it is also a blessing, if we realize that the same old cause factors are always hanging around, waiting to catch the unwary and inept, as well as "the sharpest pilot in the squadron." Knowing this is one of our best weapons in the constant war on accidents—if we apply this knowledge before-the-fact, before the next potential accident can occur.

One way of taking advantage of lessons of the past to prevent accidents in the future was devised by SAC's 15th Air Force. They call it the ACE Program, ACE being an acronym for *Accident Cause Elimination.*

The program grew out of an analysis of a B-52 midair which revealed that of the 26 aircraft commanders on the mission only six had been B-52 ACs for more than one year. How to impart the wisdom and knowledge gained from years of experience? One answer was the ACE program. It began in January 1966 and continues today with certain refinements.

Initially, the 15th Office of Safety reviewed all SAC accidents for the previous ten years. With the aid of the Directorate of Aerospace Safety, cause factors were identified and grouped. Then summaries were prepared for each cause factor. These were the bases for a series of monthly news letters to 15th units devoted to discussion of these factors. Subjects included such items as inadequate supervision of aircrew training and operations; poor techniques in flight, on the ground, in the traffic pattern; inadequate maintenance; inadequate flight preparation.

Each letter contains one or more summaries of accidents, incidents, or Operational Hazard Reports, discussion of cause factors and a list of items for consideration by local Ad Hoc Committees. Members are rep-



accident cause elimination

resentatives of various agencies — Operations, Maintenance, the Surgeon, Weather, depending on the subject matter of the period. The job of the committees is to examine their own operations in order to ferret out and eliminate potential accident cause factors. A major benefit has been the placing of accident prevention where it belongs—in the command function.

Gradually the program has been refined until today the letters are published every two months. The format is as follows: There is a resume of a general subject and the reasons why that subject was selected. This is followed by an in-depth summary of one or more accidents or incidents and a discussion of the causes and suggestions for committee action, usually in the form of a questionnaire.

As an example, a letter may discuss several items and related causes such as:

• Pilot continued flight into an area of marginal weather,

• Progressive mental and physical fatigue,

• Crew allowed the aircraft to deviate from published low level entry and flew into mountain,

• Maintenance: electrician used poor and unauthorized procedures.

Committees, digging into their own operations in the areas covered, report to their commanders their findings and recommendations. Some results that have been reported are:

• Revisions to technical orders, regulations and manuals,

• Emergency Unsatisfactory Reports,

• Revisions to aircrew training and upgrading,

• Revisions of division, wing, squadron regulations and SOPs.

It is extremely difficult, perhaps impossible, to quantitatively measure the success of such a program. But when potential accident causes are removed, it is reasonably safe to assume that some accidents that could have occurred never happened.

Comments on the ACE Program from people involved include statements such as, "One of the best developed . . . ," (a General Officer); "One of the best programs for improvement I've ever seen," (another General); "The . . . ACE program is one of great challenge and substance . . . ," (a Colonel).

The ACE Program has been going for three years now and is considered a significant part of the 15th Air Force's accident prevention effort. It involves some hard work but it is work better spent on preventing the accident than digging through the wreckage to determine the cause. ★

FUEL MANAGEMENT. A crash landing and an incident that came mighty close to being an accident resulted from fuel mismanagement. Items:

• A T-33 flamed out after landing and had to be towed to the ramp. The bird holds 825 gallons and was serviced with 824 gallons. Usable fuel is considered to be 813 gallons. How close can you cut it?

• Shortly after becoming airborne during a touch-and-go, the front engine of an O-2 quit. The fuel selector was on the left tank, which read EMPTY. The IP switched to the right main but the rear engine also quit. It caught momentarily but quit again. Both pilots were injured in the ensuing crash landing.

In the case of the T-Bird, the pilot was somehow suckered into making a flight without sufficient fuel reserve—perhaps by a 30 minute delay in receiving a clearance.

As for the O-2, the accident occurred on the seventh touch-and-go. Where was the checklist?

AEROBITS

RAIN REMOVAL. After an F-4 landed short, the Board determined that the primary cause was pilot error, which doesn't tell us anything until we examine the contributing causes. These were weather and a visual approach in weather that reduced visibility. Probables were lack of high intensity approach lighting and failure to use the aircraft rain removal system.

Water (rain) can fool a pilot when it distorts what he sees through the windscreen. Objects tend to appear lower than they are, and this can cause a pilot to believe he is higher on the glideslope than he actually is. In this case, the aircraft hit short of the overrun. It's happened before, sometimes with fatal results. Granted, most rain removal systems leave much to be desired, but why not use anything you've got going for you when things get sticky?

WE HAVE A TENDENCY to regard all landings as routine. How's this for an unusual occurrence?

The lieutenant was receiving a route and area familiarization flight. Prior to landing, the field was dragged twice to inspect for livestock and field condition. A man on horseback was observed to the side of the strip and appeared to be watching the landing operation. After the aircraft touched down the horseman, with another horse in tow, started to cross the strip from right to left. The lieutenant veered left to pass in front of the leading horse, and at this instant, the horseman saw the aircraft and spurred his horse to expedite crossing. The pilot then veered right and cut off all switches, but the aircraft hit the horse in tow, decapitating it. The aircraft fell off on the right wing damaging the right main gear, the right wing, and bending the propeller. The horseman was intoxicated and used poor judgment in attempting to cross the strip when he did. Drinking and crossing landing strips on horses don't mix.

B-57 NEAR MISS. The pilot of a B-57B filed an Ops Hazard Report on a near-miss with a civilian aircraft that brings out some points of interest to both pilots and controllers. The pilot reported: ". . . departure instructions were to proceed to the VORTAC, then out the 282 radial, remain below 3000 feet until 16 miles west of the VORTAC. While following these instructions I had a near-miss with a light aircraft at 2500 feet about a half mile west of the VORTAC. I was turning left to track out 282, and a hazy sun made visibility bad. The other aircraft flashed overhead about 50 feet above me. He was in level flight, heading about 300 degrees. Single control aircraft keep a pilot busy making frequency changes, controlling airspeed, and attempting to follow departure instructions . . . so why compound this by keeping high speed aircraft down among light aircraft traffic, especially since they have the ability to rapidly climb out of this area?"

During the investigation, controlling agencies replied that the tower advised this pilot to contact departure control immediately after takeoff, but that the pilot didn't establish contact until about seven miles from the base. At the time of contact, the B-57 pilot asked what a light aircraft was doing near the VORTAC, but didn't advise of the near-miss which would have initiated an immediate FAA investigation. At the time of the near-miss, the controller was handling an airliner that was over the VORTAC, but couldn't paint the light aircraft due to hills in the area. The rough terrain also prevents pilots from contacting departure control while on the airfield. Controllers generally keep departing aircraft at 3000 feet until they are 16 miles out, due to heavy approach traffic to a nearby civil terminal . . . but they try to give climb instructions as soon as traffic permits.

The investigator made a recommendation that should be considered by all controlling agencies. He recommended that the tower have all IFR departures switch to departure control, monitor guard, prior to starting takeoff. (Some air bases have departures call GCA to confirm proper radio channelization when departure control cannot be reached by aircraft on the runway.)

He also recommended that pilots report near-misses as early as possible to permit an investigation while all pertinent facts are readily obtainable. However, in this particular case, the fact that the light aircraft was flying on a northwesterly heading at 2500 feet indicates that its pilot was on a VFR flight and doing his part to keep separated from other traffic. Which brings up some of OUR responsibilities along this line. We should keep speed as slow as practical while in the lower altitudes and make an effort to follow the altitude separation rules, or at the very least, AVOID CRUISING AROUND AT VFR ALTITUDES WHEN ON AN IFR CLEARANCE.

UNSUITABLE SUBSTITUTE. Ejection seat safety pin X has found its way into the supply channels and has been installed in several F-100C ejection seats. Now, we all know that this type pin has been around for years and works just fine. However, if you take a close look at pin A and compare it with pin X you can see that the red streamer is attached to the head of pin A (acceptable pin).

The red streamer is attached to the ball lock release lever on pin X (the unsuitable substitute). A slight pull on the flag as you slip into the cockpit can unlock the pin and move it far enough out of the hole to negate the positive lock on the arm rest. A pin displacement of ½ inch will set you up for a serious accident.

The insidious thing about this setup is that everything looks normal at a *glance*! All operations and maintenance personnel must be aware of this hazard and the use of pin X should be discontinued until it can be modified to a configuration similar to pin A.

Maintenance personnel must be careful not to reconnect the flag on pin A through the convenient hole in the release lever. If the flag is inadvertently disconnected from its proper attach point, be sure that it is reconnected as shown on Pin A.

Reprinted from Luke AFB "Super Sabre Flash" ★

"SLIPPERY RUNWAYS AND CROSSWINDS"

I certainly appreciate Col Dwyer's kind comments (Mail Call, Jan. 1969). Let me address them in the order submitted:

a. Para 2a. Yes, I feel the pilot can be expected to avoid wet runway/crosswind formation takeoffs and landings even though scheduled by his supervisors. A flight leader presently has the prerogative of changing a formation takeoff or landing to single ship if the crosswinds are above certain limits. In the case of wet runways this should simply be another factor in the flight leader's decision. Wet runways with even a five knot crosswind can lead to an accident.

b. Para 2b. This is one that could require much discussion. However, the film strips just made public by NASA from the March-April runway grooving test show that even a four knot crosswind (not enough to dam water) can blow an aircraft as large as the Convair 990 off the runway in an amazingly short distance. Although certain local circumstances may dictate otherwise, I still believe the upwind side provides the greatest safety margin (dual-truck wheeled aircraft excepted—see "Whoops," TAC ATTACK, Nov. 68).

c. Para 2c. You are absolutely correct—the pilot must add an airspeed correction factor for gusts and crosswinds. This is why we need major changes in all our tech orders. Crosswind charts don't consider a slipperiness factor nor does the hydroplaning procedure (i.e., use of short field landing techniques) consider gust and crosswind factors. All of us who fly are caught by this one. Are you really "chicken" when you refuse to land a T-39 in a rain shower with a 10 knot crosswind? If you succeeded in landing—it was routine. If you wrecked the bird—it was operator error.

d. Para 2d. I believe that most F-4 units in SEA live with this one daily. Many times the wing supervisor of flying or the DO directs use of an alternate. And many times they simply plan to use the barrier. However, at bases with grooved runways there's no problem—just keep the tires in the grooved area.

Reference para 3 of Col Dwyer's letter—RCR has been found an invalid method of measuring runway slipperiness. (Ref NASA Report 18 and 19 Nov 68; Langley Research Center and ASTDN FTR 68-39 (ASD); "Skid Correlation Study," Lt Braeutigam, dated 30 October 1968.)

Fortunately there is a comparatively low-cost, readily available answer to all this. (See "Runway Grooving—A Real Stopper" in Nov AEROSPACE SAFETY.) NASA has proved beyond all doubt that transverse runway grooves cut in the runway surface will eliminate all forms of tire hydroplaning regardless of tire wear condition, tread design, or runway surface texture. One groove pattern tested was so effective that a wet asphalt runway was found to produce stopping distances equal to the same surface dry. This, then, virtually eliminates the need for an RCR factor. If we provide a standard (grooved) runway surface at all of our operational bases then a pilot will not need to give special consideration to slipperiness—except on ice and snow, where RCR is still relatively valid. I can't emphasize groove - pattern standardization strong enough. Already, some air installations are using less-than-optimum patterns which do help; however, we don't know by how much. Their patterns are designed primarily to provide runway drainage only. This eliminates dynamic hydroplaning but still leaves us with the possibility of thin-film lubrication skids and reverted-rubber skids. The groove pattern at Beale AFB, California, has $\frac{1}{4}$ inch x $\frac{1}{4}$ inch grooves with a one inch center covering the entire runway. This is the pattern NASA tested and found best for high speed aircraft tires.

So from the safety standpoint and from an operational standpoint I feel the answer lies in making grooved runways standard for all USAF bases. (They also help on dry runways where worn tires lose 50 per cent of their traction with less than 1/16 inch tread remaining.) One wrecked F-105 or F-4 will pay for grooving quite a few runways.

We have a serious wet-runway accident problem. Fortunately, we also have a known technological solution: Let's get grooving!

Lt Col John M. Lowery
TAC Safety

The article, "Slippery Runways and Crosswinds," which appeared in the October issue was most informative, well timed, and undoubtedly required much research. Being cognizant of these hazards and the actions to be taken if encountered are of interest to all pilots.

However, clarification should be made of the second paragraph under pilot techniques on page five of the article which states: "A TAC pilot landing an F-100, F-105, or F-4 on a slippery runway in a crosswind has three choices."

a. We observed only two choices and would like to know the third alternative.

b. Your second choice of making an approach end or mid-field engagement does not apply to the F-105 aircraft since Safety Supplement 1SS-226 states: "Midfield and approach end barrier engagements should not be attempted in the F-105 aircraft."

Maj John A. Bobel
AFSC Stan/Eval Div
Eglin AFB, FL.

Following is the author's (Lt Col Lowery) reply to Maj Bobel's letter.

You caught me red handed. During one of my many rewrites I left out the third option which is to land on the upwind side of the runway in order to give yourself maximum runway width in which to recover your traction. This would be the least desirable solution since recently released film strips of the March and April wet runway tests at NASA's Wallops Island show that even a four knot crosswind can blow you off the side surprisingly fast. You may note that the upwind side landing is contrary to the commonly taught crosswind procedure of landing on the downwind side so you'll have more runway width in which to recover from a ground loop or loss of control into the wind.

Again my writing was not precise—reference the approach end or mid-field engagement. While I did say this technique was best suited to the F-4, the approach end would be out for the F-105. The mid-field would be questionable unless the Thud pilot could get enough aerodynamic braking to slow below safe tail hook speed—say 150-145 knots. However, the whole problem is solved since the safety supplement forbids this procedure.

Many thanks for bringing these points out so that some unsuspecting young jock is not misled.

Lt Col John M. Lowery

"ALTITUDE OVER THE OUTER MARKER"

Reference page 27 of the October 1968 Aerospace Safety Magazine. The article "Altitude Over the Outer Marker" contains an error that should be corrected for the benefit of those interested.

The article states that ILS glide paths are maintained within a tolerance of $\pm$ 0.1 of a degree. This is not true. The United States Standard Flight Inspection Manual (AFM 55-8) requires operational glide paths (both precision radar and ILS) to be maintained within $\pm$ 0.2 degrees of the commissioned angle. This could increase the altitude deviation to as high as 1090 feet rather than 1040 feet published in your article.

Maj Ward J. Baker
1867 Facility Checking Sq
APO San Francisco 96274

You are correct. Par 217.5 (11) (b) 2, page 217-21 of AFM 55-8 validates your contention. $\pm$ 0.2 degrees is the maximum tolerance for both FAA and Air Force glide slope maintenance.

☆ U. S. GOVERNMENT PRINTING OFFICE 1969 341-214/6

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.

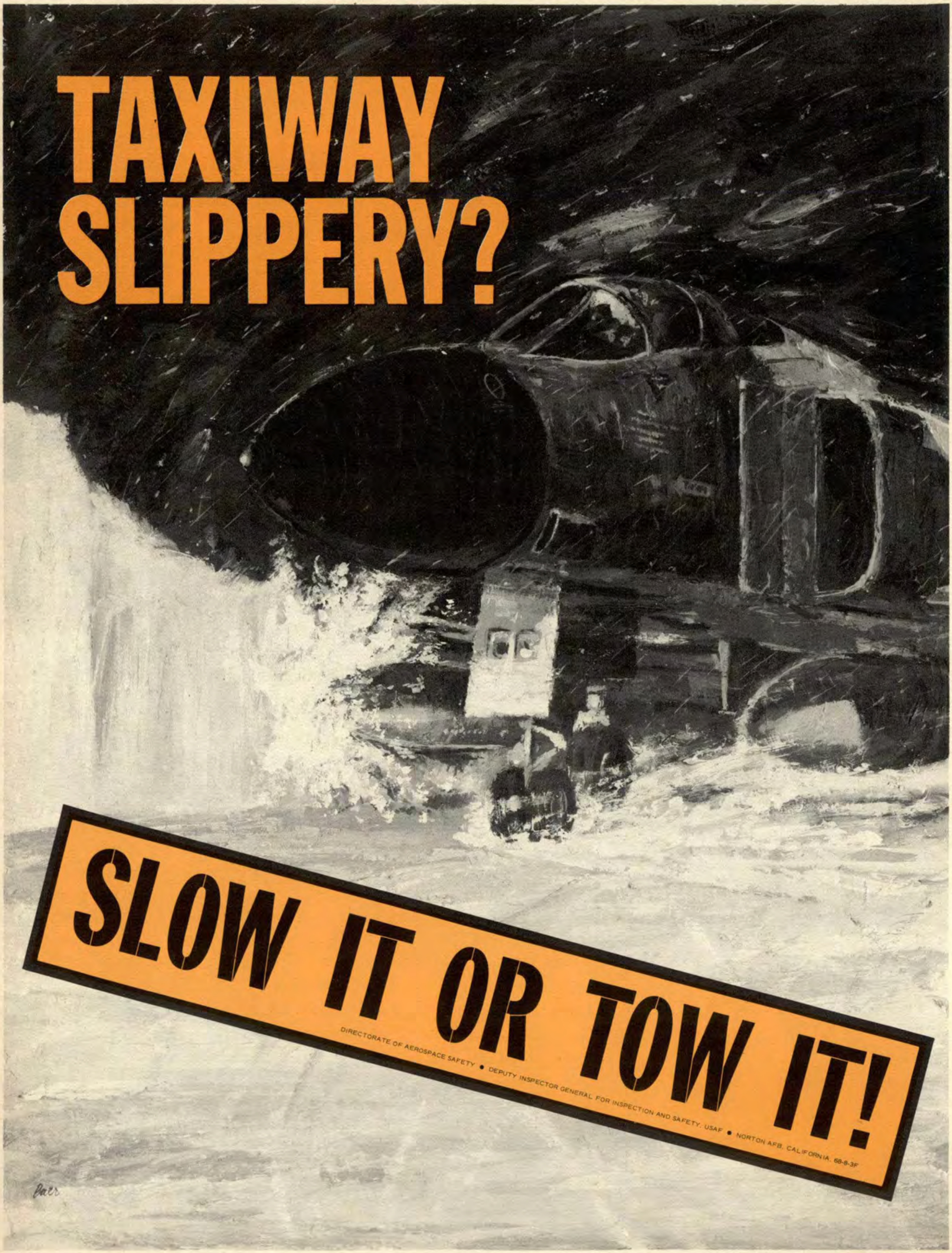
CAPTAIN Billy J. Johnson

Det 9, 38th Aerospace Rescue and Recovery Squadron, APO San Francisco 96295

On 13 March 1968, Captain Johnson was acting as instructor pilot on an HH-43F on a local pilot upgrade training flight. The first 50 minutes of flight were without incident. Then, at approximately 400 feet altitude, while the trainee pilot was performing a practice autorotation, the crew heard a loud noise and an extreme out-of-track condition was encountered. One rotor blade was observed passing directly in front of the aircraft below eye level. Captain Johnson immediately assumed control of the violently pitching and rolling aircraft. The oscillations were so severe that aircraft instruments were unreadable and visual contact with outside references was difficult. By holding full right cyclic and full left rudder, Captain Johnson was able to bring the aircraft to a level attitude at about 100 feet above the ground. In the very few seconds available to him to analyze the situation, Captain Johnson realized the normal procedure of collective pitch to cushion the ground impact could possibly cause the aircraft to roll. He therefore elected to touch down harder than normal but in a level attitude. The landing was made with no damage to the airframe or injury to the crewmembers.

Investigation subsequently revealed that a flight control rod end had failed and a rotor blade control flap was lost. Blade to blade contact then resulted in major damage to the rotor blades. This is the first known occasion of blade to blade contact in over ten years of operation of the HH-43 aircraft.

Captain Johnson exhibited exceptional alertness and a high degree of proficiency and skill in maintaining aircraft control throughout the landing. His calm, quick appraisal of a very grave emergency saved the lives of the six crewmembers and the aircraft from certain destruction. WELL DONE! ★


TAXIWAY SLIPPERY?
SLOW IT OR TOW IT!
DIRECTORATE OF AEROSPACE SAFETY • DEPUTY INSPECTOR GENERAL FOR INSPECTION AND SAFETY, USAF • NORTON AFB, CALIFORNIA. 68-8-3F