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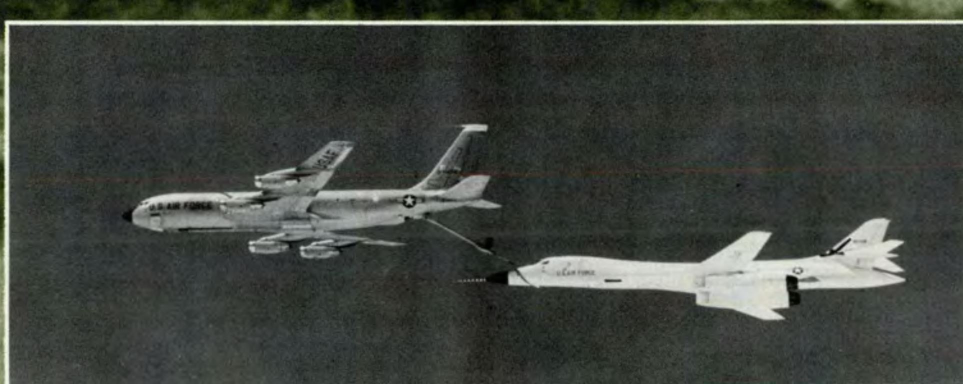
SAFETY MARCH 1976

B-1: FIRST FLIGHT+ONE YEAR



UNITED STATES AIR FORCE MARCH 1976

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

aerospace SAFETY

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MARCH 1976 AFRP 127-2 VOLUME 32 NUMBER 3

OPS TOPICS

A TIP OF THE HAT

Congratulations and a Well Done are in order for the commander and members of Air Training Command. Despite a challenging mission with some fairly high accident potential, they have achieved a truly enviable safety record. In particular, the record for 1975 is outstanding. Super job, guys, keep it up!

ATC MAJOR AIRCRAFT FLIGHT ACCIDENTS

YEAR	RATE	TOTAL*	T-37	T-38
1970	1.7	22	5	16
1971	0.8	10	2	5
1972	1.3	14	4	9
1973	1.0	10	3	7
1974	1.1	9	1	8
1975	.429	3	1	1

*The totals include other aircraft beside the T-37/T-38. T-41/T-39, etc.

GOOD JUDGMENT

A MAC C-130 pilot made a wise choice when, rather than trust a follow-me truck, he stopped to verify his wing tip clearance. The wing overlap with another C-130 was approximately 15 feet! Taxi accidents are always hard to explain. When in doubt, stop and check the clearance.

CONFLICT ALERT

FAA has completed nationwide installation of its conflict alert system which flashes a warning signal on radar displays to alert air route traffic controllers when aircraft are projected to be in possible conflict with one another. All 20 ARTCCs in the continental U.S. now have completed the initial step of the program which was to implement conflict alert in the high altitude sectors above 18,000 feet. In addition, the system was to have been operational above 12,500 feet by early February. The conflict alert system is a computer program that has been added to the central computers at the 20 centers which provide IFR service. It projects what the flight paths of aircraft will be in the next two minutes and alerts the controller when there is a possibility of a conflict between aircraft.

LOCKED BRAKE

Three F-4's had completed a local mission and were recovering by VFR overhead patterns. As nr 2 rolled out on final, he encountered mild jet wash from lead. He was able to control the aircraft without difficulty using ailerons and rudder. The aircraft touched down normally but after about 250 feet of roll, the left tire blew. It seems that, because of his size, the pilot has difficulty using rudders without applying pressure to the brakes. One of the recommendations of the investigator is for pilots to develop a habit of consciously checking foot position on the rudders before landing.

More on Page Six

When the choice is max corner velocity or take it home, would an energy maneuverability display put you on the . . .

SAFETY RAZOR'S EDGE?

MAJOR ROBERT P. (BAT) BATEMAN
Air Force Flight Dynamics Laboratory
Wright-Patterson AFB, OH

In the old days, when a pilot judged his airspeed by the sound of the wind in the wires, his altitude by the size of rooftops and his turns by needle and ball, he carried with him an internal stall sensing device known as "seat of the pants." The best turn rate was achieved by honking on the stick until the familiar burble warned him of an impending stall, But that was in "the old days. . . ."

Today's burble can mean anything from, "Your flaps are down," to "Your stick shaker is malfunctioning." The old reliable cues are gone forever. What is worse, the rules of thumb don't work anymore either. The best turn rate (corner velocity for you fighter jocks) refuses to stay at 300 KIAS, or any other speed. Today, we can go faster, higher and farther than the wildest dreams of the barnstormers, but our expanded performance envelope has only served to conceal the points of optimum performance.

We will have to find new performance criteria to measure excellence. It may not be a whole new ball game, but in air combat, the factor determining the winner is going to change. The adage, "Airspeed, altitude or GO HOME," will lose its validity when we enter the age of optimization:

Optimum Sustained Maneuvering,
Acceleration,
Climb,
Turn.

We are not there now. Not quite. Even the very best of pilots cannot consistently find the razor edge that defines the best of all possible maneuvers: *perfection.* But Jonathan Livingston Seagull lives in all of us, and we try. And just like Jonathan, we sometimes fail. But unlike that marvelous bird, we end up with more than rumpled feathers. Accidents happen because pilots, trying for that extra centimeter of performance, get into trouble before they know what is happening.

It would help if we had feedback, information on how we are doing, benchmarks of performance. Engineers know that corners exist where turn rate is optimized. Col John Boyd demonstrated the energy-maneuverability relation over ten years ago, but this vital information is still not displayed in our cockpits. A look at the cartoon to the left will explain one reason why: When the call is "Rover Flight, bogies at 5 o'clock, break right!," no jock in his right mind is going to try to interpret that maze. The second reason why a useful *energy-maneuverability display* (EMD) is not already in-

The Flight Dynamics Laboratory at Wright-Patterson is taking a look at various ideas on energy maneuverability displays to help you get the most out of your craft. Three of the possible visual arrangements are depicted here. What do you think? Here's your chance to get your ideas cranked into the design.

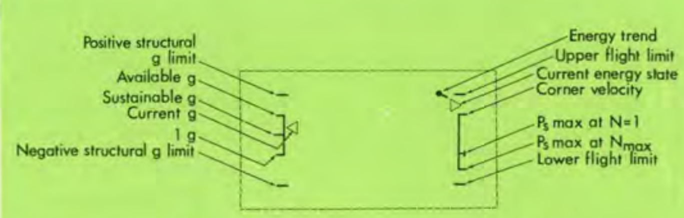


Figure 1 An Energy Maneuverability Display for the HUD
Notice that the center of the display is available for gunsight or other displays

stalled and functioning is that the parameters cannot be measured directly. Unlike altitude, angle-of-attack and heading (and all those other familiar goodies), optimum maneuver points must be computed, and until now, there has been no way to continuously solve the problem in real time.

And so, we brief estimated corner velocities at standard temperatures, average altitudes and most probable weights, and the jock with the best guess wins the hassle. Sort of like a football pool—which is kind of fun—unless you happen to be betting your life (or whatever) on the results. At this time, the prudent jock decides, golden hands or not, it's "Airspeed, altitude or GO HOME." — and that doesn't win wars.

Until now. (Blow the bugles, wave the flag, and strike up the band with a few bars of "The Stars and Stripes Forever." Those engineers have finally done us a favor. As a result of contracts negotiated by your Air Force Flight Dynamics Laboratory (end of commercial), simplified displays are being developed. On-board digital computers are available which can reduce complicated energy-maneuverability diagrams to a couple of one-dimensional displays that provide us with the option to choose the desired maneuver. The same computers will display the information we need to achieve the optimum performance we have selected.

Plainly speaking, it is possible to develop a display to give a pilot information on optimum maneuvering. The question is, "How do we display this information?" Of course, every engineer in the world has an answer, and every psychologist has an opinion. That's O.K., because having answers and opinions are their jobs. But flying airplanes is your job, and so I'll repeat the question: "How do we display energy-maneuverability information?"

Several attractive solutions have been offered. One possibility involves displaying energy state as a kind of altitude, and indicating whether a pilot needs to go up or down to achieve a desired performance. This is matched with a vertical G meter that indicates sustainable and available G's, as well as aircraft structural limits. These two vertical scales can be displayed on the HUD for easy reference (see Fig. 1). The left side (G's) shows what performance you can get now. The right side ("energy altitude") shows where you can go to do better.

On the right side, the energy trend indicator shows whether you are losing or gaining energy (or holding your own); Col Boyd's "maximum maneuver region" is shown on the right-hand side between P_s max at 1 G and P_s max at maximum G. P_s max at 1 G also serves as a benchmark for the Rutowski climb path and provides guidance for nearly optimum accelerations. The corner velocity is also displayed, along with upper and lower flight limits.

On the left side, the sustainable G limit, where P_s equals O, is shown. Upper and lower structural limits are also indicated, and when maximum attainable G is less than the structural limit, it, too, is displayed.

Referring to Figure 1, the left side of the display shows the pilot that:

1. He is pulling more G's than he can sustain, but
2. Less than available,
3. Since available G's are below structural limits, the pilot can reason that his velocity must be below the corner velocity.

The right side also tells him that:

1. He is losing energy, and
2. That he is above the altitude for corner velocity.

Corrective action to achieve the maximum turn rate (or corner velocity), assuming that throttle is already at maximum setting, and assuming that the pilot can take the action without being shot down is to:

1. Unload and
2. Descend

A key advantage of this display is that it leaves the center space available for any kind of gunsight or missile launch display that is desired. LCOS, HOTLINE and SNAPSHOOT displays are all compatible with this HUD display. It is possible to present this same information on a helmet mounted display when suitable hardware is developed. Still unanswered are the key questions, "Will it provide fight-

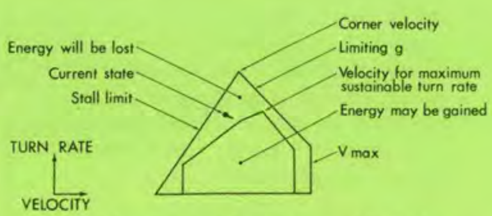


Figure 2 Two-dimensional Energy Maneuverability Display

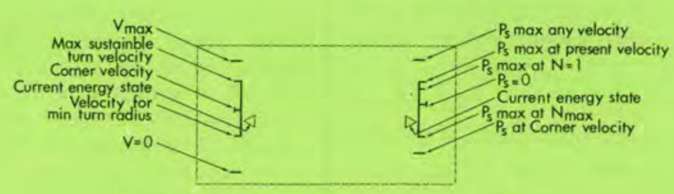


Figure 3 A third Energy Maneuverability Display

er pilots with the information they need to maintain a tactical edge over aircraft with similar characteristics?" and "Is the information presented in the best format?"

A possible difficulty may exist because a pilot must interpret energy as altitude and deduce airspeed conditions. There is a way to display key performance conditions in terms of airspeed, leaving the pilot to adjust his altitude to attain required velocities. By plotting turn rate against velocity, a nearly linear two-dimensional display results. (See Fig. 2)

The upper lines show available turn rates over a complete range of velocities. It should be noted that they do change with altitude changes. The inner polygon shows turn rate performance that can be sustained. Operation within this area allows energy to be gained; operation outside the smaller polygon results in energy loss.

Information presented in Figure 3 tells a pilot that:

1. He is turning at a faster rate than he can sustain, but
2. He can turn at a faster rate, if he is willing to accept an even greater rate of energy loss
3. Velocity is below corner velocity
4. He is losing energy
5. He is slower than corner velocity.

Corrective action to achieve the maximum turn rate, assuming that the throttle is already at maximum setting, and assuming that the pilot can take the action without being shot down is to unload. The decision to descend to attain corner velocity is not prompted by the display, but this course of action is still available to the pilot.

Actually, the same situation is presented in both Figures 1 and 2. For the display in Figure 1, airspeed must be interpreted, for Figure 2 altitude must be interpreted. There is no easy answer to this dilemma since energy exists as a combination of altitude and airspeed. The two-dimensional display may be more difficult to read than the two one-dimensional bars in Figure 1, and it lacks room for gunsight data.

Choosing a "best" EMD is further complicated by other options. The first involves reducing Figure 2 to a group of points that represent the corners of the polygons. This reduces some of the clutter without really altering the computations or information content. A second possibility is to collapse the polygons of Figure 2 onto the horizontal (velocity) axis, and then display the velocity scale vertically on the left of a display as in Figure 3. The right side is programmed to be "G" or turn rate dependent, showing on the internal scale how to manage stick forces to get energy changes at the present velocity. (Notice that P_S max at 1G, a Rutowski climb path benchmark is available, along with sustainable maneuver data [$P_S = O$].) The outer limit markers show maximum energy loss at the bottom and maximum energy gain at the top.

This display relates performance to velocity, rather than altitude and keeps the center open for gunsight data. It provides climbing as well as turning parameters. The right side shows performance available at the present velocity, the left side shows how velocity can provide improvements on these parameters. Unlike the first two displays, it has not been developed or mechanized since it is only a proposal.

Each of these displays claims the potential to give you, the pilot, the information you need in a format you can understand and use to improve your performance. What do you think?

If your interest in energy-maneuverability is great enough to devote a little more time, the following questionnaire is designed to help psychologists and engineers interpret your ideas. From all the information at hand, it appears that the F-16 is going to have an energy-maneuverability display. It is only a matter of time before one of these displays begins to share a cockpit with you. The feedback on your energy-maneuver state will allow you to elicit the absolute optimum performance from your aircraft, if you can understand it. If none of these formats meet with your approval, send us a sketch of your own ideas.

Mail sketches, questionnaires, and comments to:

AFFDL/FGR
ATTN: Maj Bat Bateman
WPAFB, OH 45433

ABOUT THE AUTHOR

Major Robert P. (Bat) Bateman completed flying training at Webb AFB, Texas, and served there as an instructor. Later he was assigned to the 8th Tactical Bomb Squadron at Clark AB and completed 225 combat missions in the B-57, many of them at night under flares. After short stints in the F-100 and F-4D, he was assigned to Nellis AFB, Nevada as an F-111 pilot.

He is a distinguished graduate of SOS and has a Masters Degree in Astronautical Engineering from AFIT. After a return trip to SEA, where he served as Battle Staff Operations Officer in the airborne command post, he was assigned to the Air Force Flight Dynamics Laboratory, Crew Systems Integration Branch. He heads the Digital Applications Group and manages Energy - Maneuverability Display Development.

He has been awarded the Silver Star, the Distinguished Flying Cross with 3 oak leef clusters, the Meritorious Service Medal, the Air Medal with 13 oak leaf clusters, and the Air Force Commendation Medal. ★

QUESTIONNAIRE:

On a reproduction copy of this page or a separate sheet of paper (in order to save this magazine for the next reader), please complete this questionnaire. Rush your answers to:
AFFDL/FGR
ATTN: Maj Bat Bateman
WPAFB, OH 45433
Thanks for the effort; your answers will be used.

After selecting your answers, enter the appropriate number in the corresponding block.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36

BLOCK 1 - *YOUR STATUS*

Non Rated	(0)
Rated Pilot	(1)
Navigator	(2)
Other	(3)

BLOCK 3 - *FLYING TIME*

0	(0)
1 to 1500 hours	(1)
1501 to 3000 hours	(2)
3001 and over	(3)

BLOCK 5 - *YEARS RATED*

0	(0)
1 to 3 years	(1)
4 to 8 years	(2)
9 years and over	(3)

BLOCKS 7 - 12 - *RATED EXPERIENCE*

Enter in Blocks 7 - 12 the codes for the planes (up to 3) you have flown most (at least 100 hours)

01	F-4	11	A-7	21	F-106	31	T-38	41	B-52	51	C-5
02	F-15	12	A-10	22	F-102	32	T-33	42	B-58	52	C-135
03	F-16	13	A-1	23	F-101	33	T-37	43	B-47	53	C-141
04	F-105	14	B-57	24	F-104	34	T-28	44	B-66	54	C-130
05	F-100	15	F-111	25	F-89	35	T-41	45	FB-111	55	C-123
09	Other Similar	19	Other Similar	29	Other Interceptor	39	Other Pilot Trainer	49	Other Bomber	59	Other "C"

61	KC-135	71	RF-4	81	OV-10	91	HH-34
69	Other KC	72	RF-101	82	O-1	92	HH-53
		73	RB-57	83	02	93	CH-3
		74	U-2	89	Other FAC	94	HH-43
		79	Other Recce			99	Other Choppers

Category not listed above, enter 00
(Seaplanes, Utility, Weather Recce, Experimental, Etc.)
(Naval or Marine Aviators attempt to classify type before selecting 00)

BLOCK 14 - *YOUR RANK*

Enlisted	(0)
0-1 to 0-3	(1)
0-4 to 0-5	(2)
0-6+	(3)
Other	(4)

BLOCK 16 - *ENERGY-MANEUVERABILITY INFORMATION IS:*

Worthless	(0)
Possibly of use to someone else but not me	(1)
Possibly useful to me	(2)
Definitely useful to me	(3)

BLOCKS 18 - 20 - *LIST IN ORDER OF IMPORTANCE THE THREE MOST VITAL ITEMS OF INFORMATION FOR MAXIMUM PERFORMANCE MANEUVERING*

Corner Velocity	(1)
Maximum Sustained Turn Velocity	(2)
Ps (Energy Rate)	(3)
G Load	(4)
Rutowski Climb Path	(5)
Best Acceleration Velocity	(6)
A/S	(7)
Altitude	(8)
Alpha	(9)
Something Else	(0)

BLOCK 22 - *THE ENERGY - MANEUVERABILITY DISPLAY*

Is Not Needed	(0)
Should Be On Instrument Panel	(1)
Should Be On HUD	(2)
Should Be On Helmet Visor	(3)

BLOCK 24 - *OF THE DISPLAYS DISCUSSED, I LIKED:*

None	(0)
Any One, No Opinion.	(1)
Fig. 2, Altitude Energy Display	(2)
Fig. 3, Two-Dimensional Display	(3)
Fig. 4, Airspeed Energy Display	(4)

BLOCK 26 - *IN MY OPINION, AN ENERGY-MANEUVERABILITY DISPLAY COULD BE USED FOR:*

Nothing	(0)
Training Only	(1)
Combat and Training	(2)
Other Mission	(3)

BLOCKS 28 - 34 - *INFORMATION FROM AN EMD COULD GIVE A PILOT AN ADVANTAGE IN:*

	No	Yes
Turning	0	1
Climbing	0	1
Accelerating	0	1
Learning Performance Limitations	0	1
Extending Range	0	1
Defeating Hostile Aircraft	0	1
Saving Fuel	0	1

BLOCK 36 - *AIMING/SIGHTING INFORMATION SHOULD BE PRESENTED:*

On The HUD	(0)
On A Helmet Visor	(1)
On A CRT Or Radar Scope	(2)
All Of The Above	(3)

OPS TOPICS

HOT START

The KC-135 crew had responded to an alert. When they attempted to start engine nr 4 the cartridge fired but after the throttle was brought to idle, the crew chief reported no ignition noise. The rpm built to about 25 percent and then began to decay. Then the crew chief discovered a fire in nr 4. The crew and the crew chief extinguished the fire with a portable fire bottle. The fire occurred because an intermittent circuit breaker failed to provide ignition with the throttle in idle. This allowed fuel to pool in the engine and to be ignited by the hot gases from the starter cartridge.

SLUSH + COLD = GEAR UP LANDING

An EB-57 took off after taxiing through slush on the taxiways. The gear was cycled at five and again at 10 minutes after takeoff to insure proper operation. However, when the pilot tried to lower the gear for landing 1 + 50 after takeoff, the nose gear would not come down because it was frozen in the well by an accumulation of ice. The ice formed from slush splashed into the well during taxi. Since the aircraft had insufficient fuel to divert to a warmer alternate, the crew made a gear up landing.

LOOK AGAIN

When the T-39 took off from an intermediate stop, the right overwing fuel filler cap departed. The cap had not been opened during refueling since single-point was used. The aircrew checked the caps visually on preflight. The AO discovered the cap undamaged beside the runway about two hours after the T-39 took off.

IT CAN HAPPEN

The T-39 was cruising at FL 290 when the crew heard a boom. The cabin pressure fail light came on, and the cockpit and cabin filled with fog. The cabin altitude went from 7500 feet to 25,000 feet in about 10 sec. Fortunately the crew was well trained and prepared for such an emergency. They had briefed the passengers properly so there were no injuries or difficulties. How long since you reviewed your emergency procedures for loss of pressurization?

IT'S THE LITTLE THINGS THAT COUNT

The student pilot was attempting to fly a circling approach at a strange field. The IP demonstrated the proper downwind position and gave control of the T-38 to the student. During the turn to final, the student mistook an asphalt taxiway for the landing runway. The IP, concerned with altitude, airspeed and glide path, neglected to identify the error in alignment until just prior to touchdown. He recognized the mistake when he realized that aircraft are not usually parked along active runways. Neither the IP or the student used any of the visual clues available for alignment such as runway markings, VASI lights and aircraft/runway heading comparisons. The visibility was 40 miles on this day. Suppose it had only been two miles!

OPS TOPICS

OLD LESSON RELEARNED

Every now and then an old lesson comes back again, sometimes the hard way in the form of an accident. Here's an incident in which the pilot was lucky. The flight of fighters was landing on runway 15 with winds at 270, 17 gusting to 21 kts. Tailwind component was 10 kts and crosswind component 19 kts. Other aircraft had reported considerable turbulence on short final. With the wind in mind, the pilot flew an excessively fast final and touched down long and fast. Aerodynamic braking was not tried, because of the crosswind. The drag chute was immediately deployed but the risers broke and the canopy streamered. Brakes just weren't going to do the job, so the pilot lowered the hook and the BAK-9 worked as designed. Good! Nobody got hurt. But it cost the Air Force $5,000 to replace the tires, brakes, and antiskid. The lessons are obvious here. But do we have to keep relearning?

LAST CHANCE WORKS

The student pilot preflighted his T-38 and found no problems, so he started engines and taxied out for takeoff. The last chance maintenance inspection discovered a leaking main gear strut so the mission was aborted. Subsequent inspection revealed that the main gear strut was cracked.

FOD AGAIN

During post flight inspection, maintenance personnel found damage to nr 1 engine. The pilot had experienced no problems while airborne, and a check of the aircraft showed no fasteners or parts missing. There were no thread marks or other means of identifying the cause of damage. However, there are some possibilities. There were loose chunks of ice on the taxiways, and winter has caused some break up of the runway and taxiways. So as a precaution against blown objects, the unit involved has increased taxi spacing to 500 feet.

WRONG WAY

During preflight, an alert crew chief recognized that the ejection seat knee guard on a T-37 was rubbing the map case. Egress personnel found that the copilot's and pilot's seats had been transposed. The seats had previously been stenciled improperly, and the only difference between the seats is the knee guard position. The knee guard must be on the outboard side. If it is inboard it will strike the map case and possibly prevent a successful ejection. In adddition, the pilot does not have proper knee protection in this instance.

NO HOOK

The HH-1 flew a local instrument training sortie. During preflight the crew found no discrepancies, but after landing they discovered the hoist hook missing. The cable had uneven end strands and evidence of rust on the interior strands. Evidently air loads and oscillation caused the weakened cable to break. ★

"Military helicopter crashes . . . Chopper was on a personnel transport mission when radar contact was lost. No May Day call was received; however, ground witnesses reported the helicopter appeared to break up and come apart in the air. There were no survivors among the crew of four and fifteen passengers on board."

the WINGS

MAJOR ROBERT L. GARDNER
Directorate of Aerospace Safety

Does this news bulletin sound familiar? Unfortunately, several accidents similar to this have occurred in the past two years. And what is the first suspect? You guessed it—main rotor blade failure.

Rotor blade failure is not a common occurrence and investigators seldom find it to be the cause of helicopter accidents. But when it does happen in flight, the results are catastrophic: loss of control ending with total destruction of the aircraft. Because of the lack of an in-flight escape system, death is the probable fate of those persons on board.

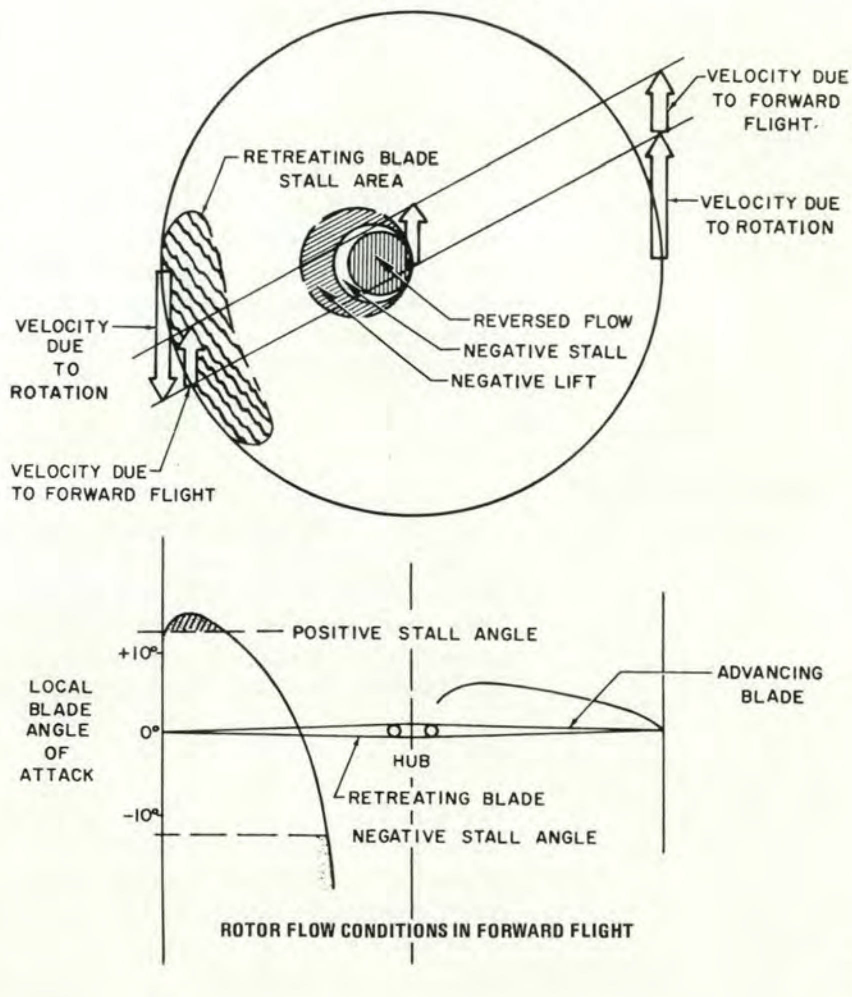
To a helicopter the main rotor blades are what the wings are to the conventional fixed wing airplane. The airplane derives its lift from a fixed airfoil surface, while the helicopter derives lift from a rotating airfoil known as the rotor. As you might expect, the word "helicopter" is derived from the Greek words meaning "helical wing" or "rotating wing."

Lift generated by the rotating wing enables the helicopter to accomplish its unique mission of hovering motionless in the air, taking off and landing in confined or restricted areas and autorotating to a safe landing following a power failure. But the generation of lift by a rotating wing is also responsible for some of the unusual problems encountered by helicopters. For example, let's briefly look at some of the different and varying forces which act on a rotor blade.

The first point to realize is that the rotor is subject to the same physical laws of aerodynamics and motion that govern flight of the fixed wing airplane. But the manner in which the rotor is subject to these laws is much more complicated due to the complex flow conditions.

Figure I illustrates a typical variation of blade angle-of-attack for various spanwise positions along the advancing and retreating blades of a rotor at high forward speed. There is a region of positive angles-of-attack resulting in positive lift over the entire advancing blade. Immediately next to the hub of the retreating blade there is an area of reversed flow where the velocity due to the forward motion of the heli-

FIG. 1
APPLICATION OF AERODYNAMICS
TO SPECIFIC PROBLEMS OF FLYING



ROTOR FLOW CONDITIONS IN FORWARD FLIGHT

OF A HELICOPTER

copter is greater than the rearward velocity due to the blade rotation.

The next area is a negative stall region where, although the flow is in the proper direction relative to the blade, the angle-of-attack produces a negative stall. Progressing out the retreating blade, the blade angle-of-attack becomes less negative, resulting in an area of negative lift. Then the blade angle becomes positive again, resulting in a positive lift region. The blade angle continues to increase until, near the tip of the retreating blade, the positive stall angle-of-attack is exceeded, resulting in the stalling of the tip section. This wide variation in blade section angles of attack results in a large variation in blade section lift and drag coefficients. The overall lift force on the left and right sides of the rotor disc are equalized by cyclically varying the blade pitch, but the drag variation is not eliminated. This drag variation causes a shaking force on the rotor system and contributes to the vibration of the helicopter.

This continuous changing of lift and drag forces causes the rotor blades to flex and bend like a snake on a hot tin roof. This is vividly portrayed by viewing high speed motion pictures of a rotating blade.

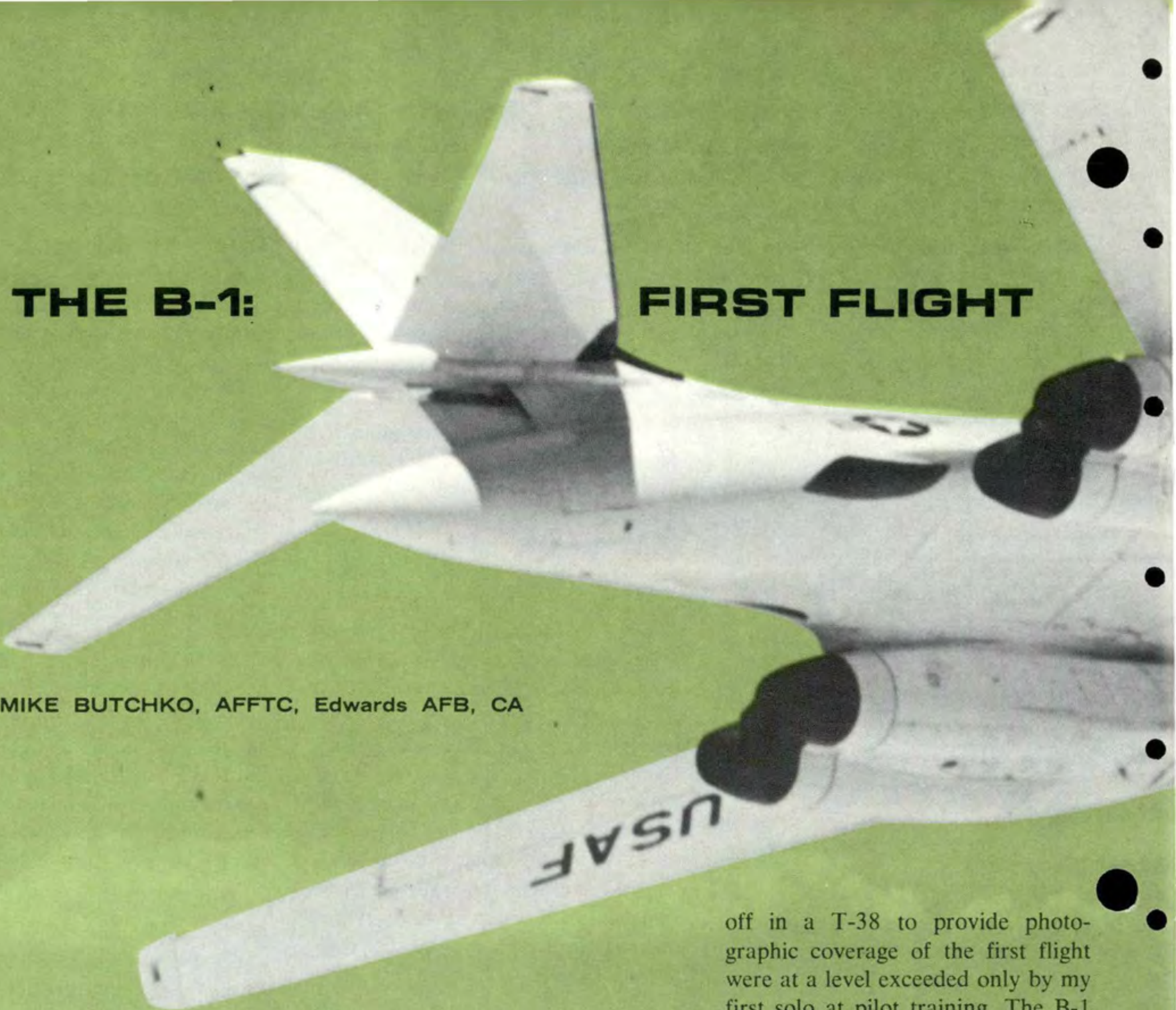
The point is, helicopter main rotor blades are subjected to repetitive cyclic stresses. A small scratch, a tiny corrosion pit or inclusion on a blade spar can quickly induce a fatigue crack. Continued operation, particularly at high airspeeds will cause a spar crack to propagate and may result in failure in a matter of hours. Some helicopters have a blade inspection method (BIM) system which detects blade spar cracks. Other helicopters do not have a detection system and must rely on visual inspection to insure airworthiness. No matter what type helicopter, the maintenance and aircrew visual inspections are of primary importance in determining proper condition of the rotor blades.

Not long ago a blade was removed from an H-53 helicopter due to a *black* BIM indicator. At the overhaul facility it was noted that the blade possessed obvious lightning damage at the leading edge of number six pocket and at two places on the trailing edge of the same pocket. The lightning strike damage at the leading edge point had burned a small hole in the pocket and pitted the spar. Teardown revealed that the spar had cracked at the pit caused by the lightning strike. This blade was at the point of total separation which would have been catastrophic.

In-cockpit BIM systems will be installed in Air Force H-3 and H-53 helicopters. In addition a low stress rotor blade is being developed for the H-53. Incorporation of these improvements will enhance the spar crack detection and integrity of the rotor blades on these helicopters.

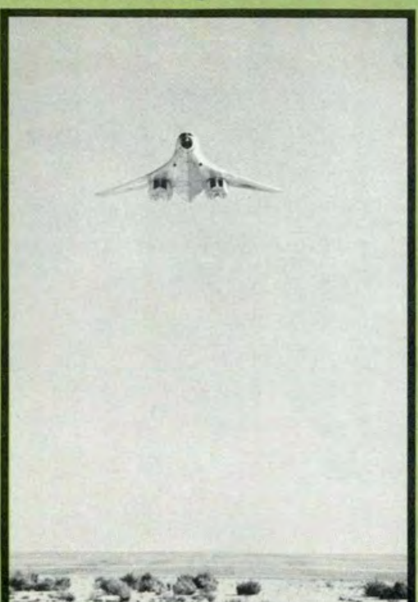
Although these modifications will provide additional safety factors, we must still rely on strict compliance with preflight and postflight inspections to detect damage and condition of blades. That is up to us. ★

THE B-1: FIRST FLIGHT



MAJOR MIKE BUTCHKO, AFFTC, Edwards AFB, CA

Now in its second year, the B-1 flight test program has been a carefully orchestrated combination of achievement and safety. The author describes some of the test program milestones and tells what's coming.



A major milestone toward modernizing the Air Force strategic bomber force occurred on 23 December 1974. That date marked the first flight of the Rockwell International B-1. A year later, 23 December 1975, the development program had accumulated over 110 hrs of flying time and was well on the way to opening the B-1 operational envelope. This article will cover the highlights of the first year's flight test activities, some of the unique safety controls applied to the B-1 program, and will take a look at the year ahead.

The first flight of a new aircraft is a tense and exciting event. All of the designing, manufacturing, ground testing and planning efforts are complete and everything is on the line. My feelings waiting to take off in a T-38 to provide photographic coverage of the first flight were at a level exceeded only by my first solo at pilot training. The B-1 flight profile, with a Rockwell pilot in the left seat and an Air Force pilot in the right, was actually quite conservative with the aircraft remaining in the takeoff configuration for the entire flight. The 1.3 hour mission verified the initial airworthiness of the aircraft and the engines. It also gave the pilots and engineers confidence in the handling qualities of the aircraft in the takeoff configuration. The mission was completely successful and a tremendous Christmas present to the entire B-1 Test Team.

With the first flight milestone accomplished, the B-1 was ready to begin envelope expansion in its primary low-altitude high speed operational environment. The first year's primary goal was to clear the aircraft for initial operation at 0.85 Mach at 500 feet.

PLUS ONE YEAR

The second flight was significant in that the landing gear, flaps, slats and wing sweep systems were activated for the first time. With the aircraft in a "clean" configuration, the flying qualities were given an initial evaluation out to 0.72 Mach at 16,000 feet. The crew then verified that the two auxiliary power units (APU) would start in flight.

Flights three, four and five expanded the medium altitude envelope to .75 Mach and 23,000 feet. APU assisted airstarts of the General Electric F101 turbofan engines were demonstrated. Of even greater significance, were the initial hookups with the KC-135 tanker for aerial refueling. No fuel was transferred during these hookups, but the capability to refuel in flight was validated.

The flight test program now moved west to the offshore test corridors of the Space and Missile Test Center (SAMTEC) and Pacific Missile Test Center (PMTC), where virtually unlimited airspace was available while still providing real-time telemetry of data to the Edwards Control Center. Flight six

All AF flight crew for B-1 Flt #16 being given final preflight briefing. L to R—Lt Col Richard Smith, Chief Joint Test Force Engineering, Col Emil Sturmthal, Pilot (JTF director), Lt Col Edward McDowell, Copilot, Mr. Pat Sharp, Flight Test Engineer.

Joint Maintenance Concept—AF both evaluates and performs maintenance tasks. L to R—MSgt Stephen Saathoff, Rockwell Technician, TSgt Loyd Russell Bateman. NCO's are members of SAC 4200th Test & Evaluation Sq.

put the corridor to good use. Supersonic flight was achieved during the 6.4 hour mission; a top speed of 1.05 Mach was reached at 29,500 feet. The first "wet" hookup was made with the KC-135 during this flight and 53,000 pounds of fuel were transferred. Refueling is now a routine part of nearly every mission making valuable additional test time available. Fuel transfers in excess of 100,000 pounds have been made on a single contact and maximum in-flight gross weight of the aircraft has been achieved. These refuelings have made mission durations of over six hours a common occurrence in the program. Strategic Air Command tanker crews have provided invaluable assistance to the B-1 flight test effort.

The next phase of testing concentrated on flutter investigations to prove that the basic design of the aircraft would support low-altitude, high-speed flight. Flutter is defined as a dynamic instability of structural components, particularly on wing and tail surfaces. It is a very rapid vibration that can lead to catastrophic failure of the fluttering surface. These tests verify that the aircraft is flutter free throughout its operational envelope. Flights eight through 13 were primarily involved with these flutter tests. The operational envelope was opened to 1.25 Mach/29,500 feet at high altitude and .85 Mach/3000 feet in the low altitude environment. Flight eight was particularly significant in that it marked the initial maximum gross weight takeoff of the aircraft.

The higher-faster and lower-faster pursuit continued. An all-Air Force crew flew for the first time on flight 16. Flight 17 reached 1.4 Mach. The initial goal of the first year's testing was achieved on the 18th mission. The B-1 flew at .85 Mach at 500 feet over the SAMTEC offshore range on 9 October 1975. A 7 hour and 52 minute flight 19 was the first of a continuing series of low-altitude, high-speed overland flights. Thus far these flights have ranged from 500 to 2000 feet above ground level (AGL) and have served two important functions. First, they provide valuable information on pilot workload and aircraft response in the terrain following mode of operations. Second, the Structural Mode Control System (SMCS) is being given a thorough operational evaluation. The SMCS is designed to smooth the ride by damping out the effects of turbulence. Without such a system, operating an aircraft as large as the B-1 at high speeds and low altitude could be severely limiting to crew performance. It would be similar to trying to fly an accurate ILS approach in a thunderstorm.

In addition to the low altitude work, the next series of flights, 20 through 24, began the step-by-step move toward the secondary mission of the B-1. This is the high-altitude, high-mach mission. Supersonic flutter and propulsion tests have begun. To date the B-1 has achieved 1.6 Mach and 50,000 feet.

Flight 25 concentrated on the more routine aspects of testing. It gathered data on subsystem and aircraft performance to start filling in the details of the center of the operational envelope. While not as exciting and as glamorous as envelope expansion, these tests are equally important. They lead to determination of optimum flight conditions — best climb schedule, best cruise mach/altitude, etc.

The flight test program has been extremely successful thus far. Some problems have cropped up and not all missions went exactly as planned. But these occurrences are commonplace in the development of new aircraft. The important thing is that as each problem has surfaced, a fix has been determined and the corrective action taken. The aircraft has not been exposed to any unnecessary risks. In fact, the high level of interest in the B-1 has resulted in a very comprehensive safety program that is worthy of further discussion.

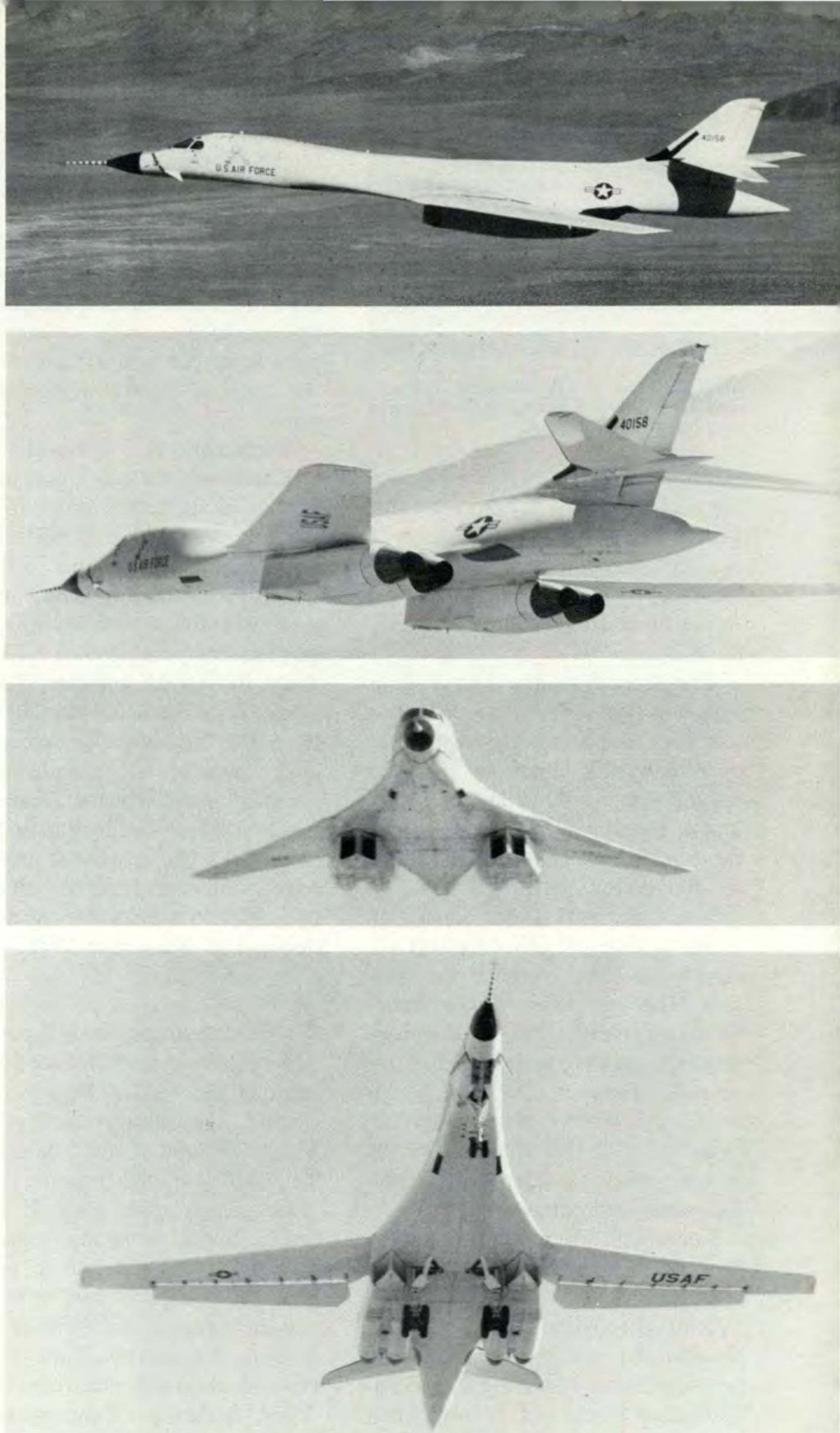
The old cliche, "Safety is paramount," has had particular significance to those of us involved in the B-1 program. While the loss of any aircraft is significant, the loss of the only asset currently flying in the test program would be catastrophic. With this in mind, the safety controls for the B-1 have been stringent.

The readiness for the first flight and its profile were reviewed at the highest levels of Air Force Systems Command (AFSC) and USAF through independent first flight readiness review teams. NASA conducted a month long system safety review. AFSC directed an Executive Independent Review Team. Finally, the Air Staff implemented a study called Corona Quest to verify that the aircraft and aircrew were ready for first flight. These studies were in addition to the in-house reviews held by the System Program Office (SPO), Rockwell International (RI), and the Air Force Flight Test Center (AFFTC).

To some, it might seem that we have had an excessive amount of "help." But it must be kept in mind that the B-1 is a very high interest program. The production decision for the B-1 is yet to be made. The members of the Defense System Acquisition Review Council (DSARC) and the Congress need flight test data to make an accurate assessment of the B-1's readiness for production. With only one B-1 to provide the data for the first year, no valid safety input could be considered excessive. Or stated more simply: no aircraft, no data and no production decision! Neither the program nor the nation could afford to lose the first B-1 aircraft.

The crunch comes in sorting out what is necessary and what is excessive in terms of constraints. We need the maximum number of milestones accomplished. Each milestone involves envelope expansion. Envelope expansion is by its very nature a hazardous undertaking. The job in the B-1 program is to control the hazards and keep the risks down to an acceptable level. The earlier and the on going efforts have done this and are continuing to do so. Some of the efforts are standard to all test programs. Some are unique to the B-1 program. I will briefly mention two that are unique.

The first involved an Air Staff interest in the physical condition of the flight test aircrews. Both the contractor and the Air Force crew continued



Series of photos show various aspects of B-1 flight test program. Top and bottom photos show swing wing in different positions.

Wing pivot test at LTV laboratory. Hydraulic rams put vertical and torsional loads on dummy wing box attached to pivot.

members have to have a complete physical within 60 days of their first flight in the aircraft. In addition, a physical screening of each crew member is conducted by an Air Force flight surgeon prior to every flight.

The second unique aspect deals with the test operations. All new test aircraft are initially required to operate in VFR conditions and with a safety chase aircraft in close proximity. The B-1 also operates under these same restrictions. In addition, the B-1 is restricted to positive control airspeed with radar separation provided from all other aircraft not directly involved in the B-1 formation. This restriction, while sometimes inconvenient, imposed no significant restraint on the number one aircraft. However, the restriction is being reviewed for possible modification to allow for operation of the number three aircraft in the terrain following environment.

The major difference between the B-1 safety program and that of other programs is the level of "between flight reviews." Test plans for all aircraft tested at Edwards undergo the scrutiny of the AFFTC Safety Review Board before testing can start. The B-1 review process goes further. To implement an Air Staff requirement of "continued reviews," a formal operations/safety review panel was formed to assess each planned flight. I chair the panel which is composed of members representing the B-1 Joint Test Force, AFFTC Engineering, AFFTC Safety, the Contract Management Office, and Rockwell Safety. Our charter is to ensure operational and safety readiness for each flight. This is done by looking at the previous flight's results in light of how they support the objectives of the upcoming flight. The review panel concept has been quite successful and has provided vaulable recommendations in specific test areas to control the level of hazard involved in the tests.

The second year of B-1 flight test will undoubtedly see some modifications in the safety program since the test program itself will change significantly. Aircraft one will continue to lead the way. The third aircraft will fly in late spring, while the number two aircraft will start flying during the summer. The apparent disparity in numbering stems from the fact that the second aircraft spent several months undergoing extensive structural loads testing in a special test facility at Palmdale, CA. The combined performance of all three aircraft will hopefully lead to a favorable production decision in November 1976.

Aircraft number one will continue to do extensive performance and flying qualities tests. These tests will expand the aircraft envelope to Mach 2+ and above 50,000 feet. They will also further define the low altitude high speed area of operations. Initial weapons separation tests will be conducted on aircraft one. The weapons tests will verify that the weapons will separate cleanly from the aircraft. They will not be assessing the accuracy of the drops. Accuracy measurements will be left to aircraft three through simulated weapons releases as part of the avionics demonstration. Full weapons certification will follow the production decision.

Aircraft three will be the offensive avionics testbed. It will provide the initial demonstration of the capabilities of The Boeing Company's offensive avionics system. In addition to simulated weapons deliveries, the avionics demonstration will include navigation systems development tests and terrain following (TF) development tests in both the manual and automatic modes. TF testing will follow the same step-by-step progression as other envelope expansions while working toward maximum speed at minimum terrain clearance.

Aircraft two also has a specific task. It is especially instrumented for structural loads measurements. Having successfully completed the ground loads tests, it will fly specific test profiles toward clearing the B-1 for 100 percent of design structural in-flight loads (g-loads). Air loads will be gradually increased until the design limit is reached to verify the aircraft's basic design. Only an initial investigation will have been accomplished by November 1976, but it will be sufficient to identify potential problems that might be present.

The first year of B-1 flight testing is complete and the results are impressive. However, a major effort lies aehad. If the second year is as successful as the first, a decision to produce the B-1 should be made by the DSARC. The goal of the B-1 Test Team is to ensure that success so that the proper decision can be made. Success will not come from luck but will result from a continuing aggressive safety program to control the level of the hazards involved while achieving the maximum number of milestones. ★

Major Mike Butchko presents an historical summary of the first year of B-1 flight testing. His discussion of flight test milestones, as well as an analysis of the flight safety program, provides an in-depth analysis of the highly visible thresholds the B-1 is expected to achieve prior to production decision. Major Butchko, a 1962 graduate of the United States Air Force Academy, received his MS from the University of Southern California in 1974 and is presently the B-1 System Program Office's test representative for Flight Operations and Flight Safety at Edwards AFB, CA. He is a 1971 graduate of the United States Air Force Test Pilot's School and possesses operational expertise in flight test development. The editors of Aerospace Safety *Magazine are most appreciative of this contribution.*

LT COL DAVID E. RALEY
Directorate of
Aerospace Safety

THE FSO

Photos by Aerospace Audio-Visual Service, USAF
Anyone who has spent time on the flight line knows the FSO, but few realize all the things he gets involved in. Here Major Franklin Lamb, FSO at Vandenberg AFB, lets the tower know the approach lights are functioning properly. Only one of the many ways he helps you.

It seems like the only time we see those guys is when something has gone wrong and they are asking "why?" Trying to stick it to some innocent young jock just because he ran over that yield sign out there in the runway clear zone. It doesn't matter that he was 400—500 feet low on his final approach, the manuals say you cannot have anything like that in the clear zones. Why is he down here talking to us? Why doesn't he go up and hassle the civil engineers? They are the guys that put the sign there.

That's the side of the Flight Safety Officer we most often see and remember the longest. But FSOs do a lot of other things, depending on the individual and his involvement.

Let's take the hazard reporting program (AFR 127-6). You are upset with maintenance because they cannot seem to fix the afterburner on 007 and it's caused you a couple of hairy moments. You've written it up several times in the 781, but it's still not fixed. You call for help by submitting an HR (AF Form 457).

Who now, becomes your advocate with the maintenance people? It's the FSO who was just down hassling you. He will work to ensure the problem gets to the right person and keep checking on it until it's fixed. He will then let you know what has been done. He is now a good guy in your eyes, but what about the maintenance folks? Oh well, it doesn't matter, they will need help too and ask for it by submitting an HR on some problem that just does not respond to the normal system. The friendly FSO is now a helper and this is a very rewarding and challenging role.

Now, the FSO has to ensure that the aircraft accident prevention program is responding to all the areas which can cause a mishap or create problems for the aircrew, aircraft maintenance people or anyone else associated with flying.

The FSO spends a great deal of his time working with the civil engineers on airfield problems—aircraft arresting barriers, runway and taxi markings, clear zones, pavement maintenance, etc. You name it and an FSO has been involved with it some time or another.

The air traffic control area re-

continued

Captain Richard E. Simmons, Scott AFB FSO makes regular visits to the control tower. Recently he talked with Captain Amanallah Yazdanpanah, an exchange officer from Iran who is training to become a controller in his country.

Dr. Gerald B. Pees, Hickam AFB Flight Surgeon, discusses medical aspects of an aircraft incident with FSO Captain Henry McPhillips.

THE FSO

continued

Runway construction is the subject of a conversation between Hickam AFB FSO Capt Gerald H. Lannoux, Col Henry G. Snider (Left), Civil Engineers Commander, and Col W. E. Y. Paxton (Right), Base Commander.

Captain Henry McPhillips, Hickam AFB FSO, checks on stock level of a vital part with Mr. Bunny Tong, 15th Supply Squadron.

Maintenance man TSgt Fred Schlosser points out repaired item in cockpit of a T-33 to Capt Henry McPhillips.

quires a lot of his attention—GCA, taxi routes, traffic patterns, navigation facilities, etc. He is usually a member of the local air traffic control board and, along with the other members, is constantly seeking to identify problems and correct them before something bad happens. Many FSOs have been instrumental in the development of programs to brief the local civilian pilots on military aircraft operating areas in an effort to avoid "air misses."

A good FSO spends some time in supply and usually has some pretty good contacts there. The typical supply organization is run very efficiently and provides the needed items in a timely manner. But occasionally, there arises a problem which you just cannot seem to solve and you have exhausted all the normal channels. If it is causing you problems and is interfering with safe mission accomplishment, give the FSO a crack. Sometimes his shorter and frequently informal communications channel can get the problem to the right person for a quick solution. Other times—?

The FSO learns quickly that the flight surgeon is one of his best friends and a very important ally in his accident prevention activities. When he runs into some "human" problems that he does not have answers to, he can usually get the flight surgeon to help him out. Besides, the flight surgeon has to do all the paperwork when preparing the physiological incident (hypoxias, decompressions, etc.) reports which seem to pop up now and then. Personal equipment anomalies are frequently involved in these in spite of all the emphasis that this subject receives. The FSO can be seen visiting with the life support people to help them provide the support the aircrew members need in the personal equipment area.

What about aircraft maintenance? The FSO spends a lot of time in this area due to the nature of the aircraft incident reporting system. Hardware failures are usually specific and concrete, and when one occurs that meets the reporting criteria, we have a "reportable" incident. The FSO is then tasked to ensure the report is prepared and submitted properly.

Many times he does the investigation and reporting himself, although some reports are done by quality control or someone else. In any event, the effort will receive a great deal of outstanding support from the maintenance supervisors and the quality control people. Also, with any kind of luck their coordinated efforts will result in some changes and in the long run fewer aircraft safety problems. Unfortunately, it does not always seem to work that way and as one problem is solved another appears. Oh well, this gives the FSO an exceptional opportunity to work with a lot of great maintenance people; and he will know them better when he comes around to them with their other safety problems.

Above all else, the FSO is an aircrew member and usually a darn good one. He is active with the flight operations guys and pulls his share of the bad duty along with the good. He's going to find rough going if he is the type who misses the night low altitude training missions or flare drops, but is always there for the gunnery sorties or trips to Japan. It's pretty hard to make your point when you haven't been there yourself.

The FSO is in a unique position in that he can look at the whole operation in an objective manner. And if he reads his boss, the wing commander, right he can look at it from the boss' perspective. The wing commander and his safety staff are about the only ones in the unit who do not have some parochial interest in one of the functional areas. It's a great job, and the FSO really gets to see how things go—good and bad.

P.S. His job is to solve problems for the wing, not create them. If that's not the case, well—. ★

CLEARANCE PROCEDURES

Q: What assigned altitude can I expect in a departure clearance?

A: ATC will assign an altitude based on availability, using the following order of precedence:

a. The altitude filed in your flight plan;

b. An altitude in the route stratum filed in your flight plan and as near as possible to the altitude filed; (NOTE: Route strata: High, above FL 450; Mid, FL 180 to FL 450; Low, below FL 180.)

c. An interim altitude within the route stratum filed in the flight plan or an altitude as near as possible to the route stratum filed. Also, ATC will inform you when or at what point to expect clearance to the assigned enroute altitude. Example: You have filed for FL 350. FL 230 is immediately available and FL 350 will be available ten minutes after departure or at a specific fix. The clearance will read: "Maintain Flight Level 230, expect Flight Level 350 ten minutes after departure" or "Maintain Flight Level 230, expect Flight Level 350 at the San Antonio Zero Three Three Radial, Two Four DME fix." If you experience radio failure, before receiving clearance to the expected altitude/flight level, climb to the expected altitude/flight level at the time or fix specified in the initial clearance.

Caution should be used if the final or expected altitude is lower than that used for flight planning. Do you have sufficient fuel to complete the flight to destination at that altitude, in case of radio failure? If you don't have enough fuel, request a delay until a suitable altitude is available or until ATC advises when or at what point a higher altitude will be available.

PILOT CONTROL OF AIRPORT LIGHTING

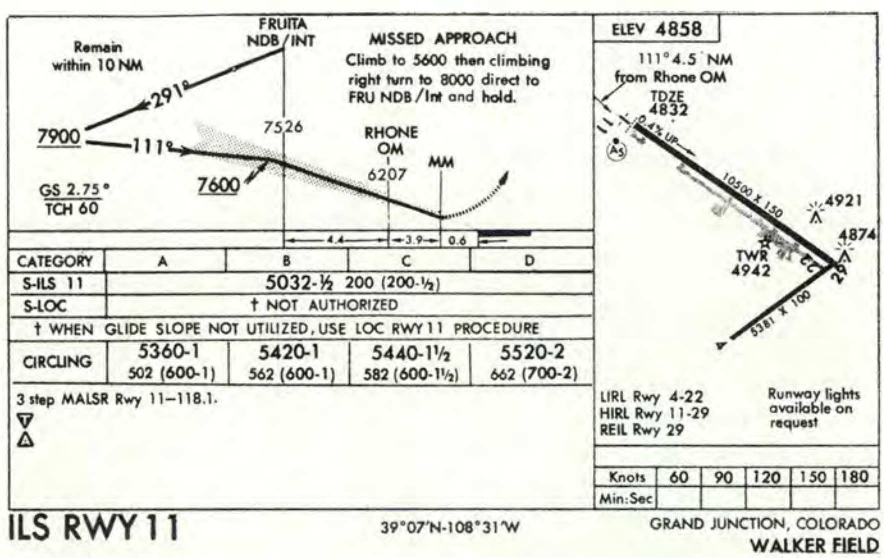
A new device is being installed at some airports which are manned less than full time. Controls are installed that enable pilots to turn on some airfield lighting systems by selecting a communications frequency and then keying the mike. Control of these lighting systems will be possible when the aircraft is within 15 miles of the airport.

The types of lights and frequencies are published on the Instrument Approach Procedure chart beneath the minimums block. Our example, Figure 1, lists a 3 step, Medium intensity Approach Light System with runway alignment indicator lights (MALSR) for runway 11. The activating frequency is 118.1.

The legend pages in each low altitude approach booklet list the number of times to key the mike to turn on either the high, medium, or low intensity of the lighting system. How would you like to be on short final after selecting low intensity and have another aircraft activate high intensity? Could be a surprise at a time when you don't really need one. BE AWARE!

Further explanation is contained in FLIP, IFR Supplement, Procedures Section and in the FAA Airman's Information Manual which you can find in USAF Base Operations.

Figure 1



CATEGORY	A	B	C	D
S-ILS 11	5032-½ 200 (200-½)			
S-LOC	† NOT AUTHORIZED			
† WHEN GLIDE SLOPE NOT UTILIZED, USE LOC RWY 11 PROCEDURE				
CIRCLING	5360-1 502 (600-1)	5420-1 562 (600-1)	5440-1½ 582 (600-1½)	5520-2 662 (700-2)

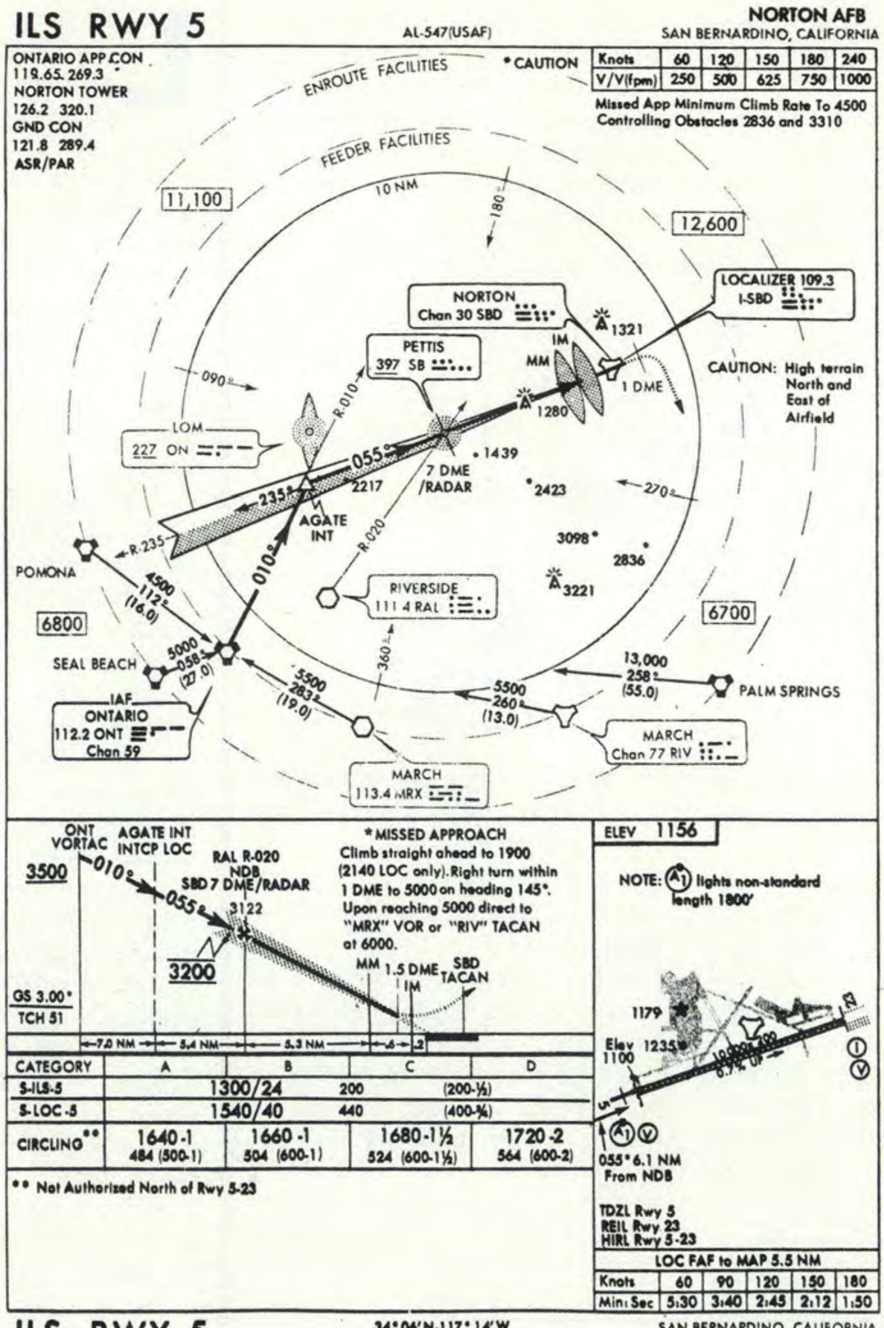
Knots	60	90	120	150	180
Min:Sec					

MISSED APPROACH

Q: What should a pilot do if he must execute a missed approach prior to reaching the missed approach point (MAP)?

A: Missed approach protected obstacle clearance areas are designed with the assumption that the missed approach will be started at the missed approach point. When it is necessary to execute a missed approach prior to the MAP, pilots should, unless otherwise cleared by ATC, start a climb and continue to fly the depicted ground track to the missed approach point. Then, execute the missed approach procedure. An example of what could happen if you made an early turning missed approach is the ILS approach to Runway 5 at Norton AFB. (See Fig. 2) On this approach an early turn may cause you to come dangerously close to the terrain and obstructions depicted to the south and southwest of the aerodrome.

Figure 2



LOST COMMUNICATIONS—ENROUTE

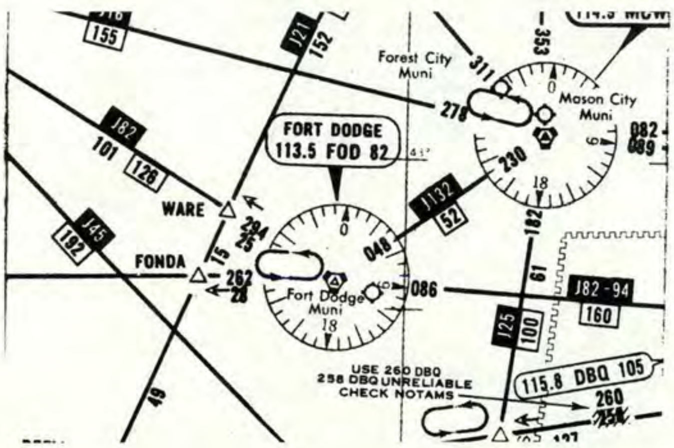
Q: If a pilot experiences radio failure after he has been given an en route clearance limit and an expect further clearance time, what actions does ATC expect when he reaches the clearance limit fix?

A: *If no holding instructions have been received,* proceed, without holding, by either (1) the route assigned in the last ATC clearance received, (2) in the absence of an assigned route, by the route that ATC has advised may be expected; or (3) in the absence of an assigned route or a route that ATC has advised may be expected, by the route filed in your flight plan.

Q: When and how will ATC specify en route holding?

A: Holding instructions will be given anytime a delay is required prior to further clearance being issued. If a holding pattern is depicted at the clearance limit, ATC will issue the direction to hold and the time at which the pilot may expect further clearance. Example: "RAMA 01, CLEARED TO THE FORT DODGE VORTAC, HOLD WEST, EXPECT FURTHER CLEARANCE AT 2130Z." (See Figure 3) When no holding pattern is charted for the clearance limit, ATC will issue *general* holding instructions or, detailed holding instructions, if requested by the pilot or considered necessary by the controller. These instructions should be given at least five minutes before you reach the clearance limit. ATC should also specify a time at which you can expect further clearance.

Figure 3

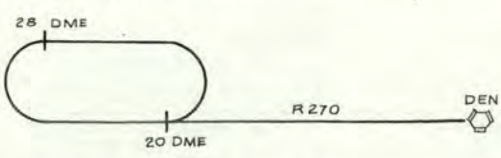


Q: What information is contained in "general" and "detailed" holding instructions?

A: General holding instructions will specify: (1) direction of holding from the fix; (2) the holding fix; (3) the radial, course, bearing, airway, or jet route on which you are to hold; (4) Outbound leg length in miles, if DME is used; (5) direction of holding pattern turns, if left turns are to be made. Example: RAMA 61, HOLD WEST OF THE TWO ZERO MILE DME FIX ON THE DENVER VORTAC TWO SEVEN ZERO RADIAL, EIGHT MILE LEG, LEFT TURNS. (See Figure 4)

Detailed holding instructions are the same as general holding instructions except the controller will *always* specify the leg length in minutes or miles DME and the direction of holding pattern turns. ★

Figure 4 HOLDING INSTRUCTIONS



KEEP IT ON THE RUNWAY—F-4

LT COL J. P. CLINE
Directorate of Aerospace Safety

Let's start out with the premise that the airplane rolls better on paved surface than in the weeds. Then, a second premise can be that we commonly encounter situations which cause us to lose directional control on the runway. These situations include crosswinds, hydroplaning, blown tires and hardover nose-gear steering.

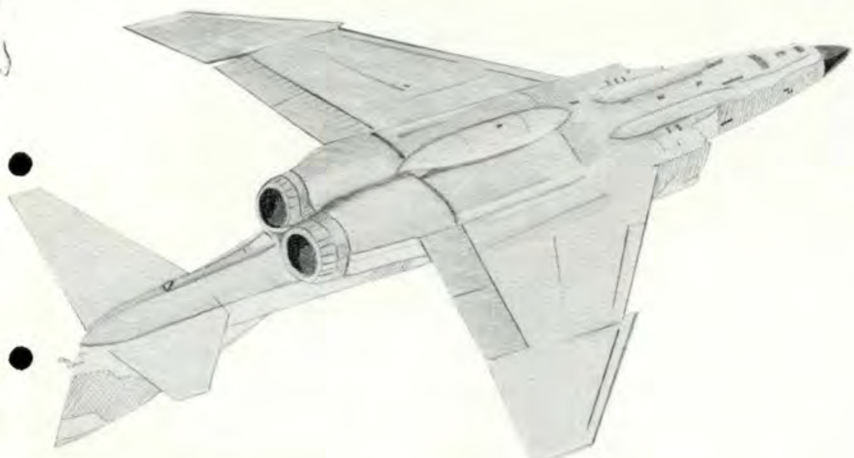
The new Mark III antiskid will give us locked wheel protection—in other words, the brakes aren't applied until the wheel comes up to speed, even if our clodhoppers are on the brake pedals at touchdown. BUT—Mark III isn't the answer to all brake problems. We will still see some blown tires so don't get too relaxed. You still must be prepared to keep the beast on the runway. Even though the nose-gear steering established its lack of reliability early in the life of the F-4 and still leaves a lot to be desired today, it is still probably the best means of staying on the runway with a blown tire. Most people avoid nose-gear steering problems by avoiding use of the nose-gear steering. BUT—don't confuse normal procedures with emergency procedures.

"NOSE-GEAR STEERING—ENGAGE" is the first bold face step in the blown tire procedure, but it is surprising how many jocks run off the runway without engaging it. Remember, the famous old axiom—use everything available to stay on the runway. ★

★ ★ ★ ★

UPSIDE DOWN! and out of ideas?

MAJ ANTHONY HELBLING, JR.
Directorate of Aerospace Safety



SITUATION: For one reason or another, you find yourself inverted and stalled.

There has always been a tendency for this attitude to progress to an out-of-control condition. This may be due to disorientation and/or (unfortunately) the wording of the bold print procedures. The problem is that our bold print responses are oriented right-side-up with respect to earth's gravity. The usual "Stick Forward" response works great *most* of the time, *except* while inverted.

Over the past several years, we have had crews depart inverted while attempting advanced handling or confidence maneuvers in the F-4. In a typical situation the stick was positioned full forward in an attempt to unload the aircraft. Instead, the pilot loaded the bird and kept it in a stalled condition until the mandatory bailout altitude or extreme confusion resulted in ejection.

This type of control loss is common to fighter/trainer aircraft during confidence maneuvers, advanced handling, and BFM/ACM maneuvers. It is, however, germane to any bird with wings. Many of our bomber and transport aircraft have bold print procedures for upright out-of-control; whereas the inverted departure is not addressed because the occurence is remote or the military specification for that particular handbook does not require the procedure due to aircraft type.

Various technical journals published by several aircraft companies, such as McDonnell Douglas' *Tiger Talk,* recommend removing the "meat hooks" from the controls in a disoriented situation. This should prevent aggravating the unknown flight condition. Good advice! . . . provided it doesn't *directly conflict with the Dash One*. The rationale for the above is: a stable aircraft will seek level flight (assuming it was trimmed for it) with the 1 G (pull of gravity) doing the work for you. This works every time, provided terrain clearance isn't a factor and the aircraft hasn't fully departed controlled flight, (needing anti-spin inputs to regain control).

Those of us with the advantage of an angle-of-attack (AOA) indicator can identify a "loaded" versus "unloaded" condition and prevent a negative G stall. However, this gage has been misinterpreted by some crews during violent departures.

A good many of our losses have occurred in the training environment (student/instructor combination). Many cues are available for a proper recovery dependent on instrumentation and aircraft type. In the F-4, there are two heads and chances are one of them is less disoriented than the other. It really pays to discuss situational emergency procedures before each flight and tailor them to the maneuvers being performed. When it happens—it's fast and disorientating! You've got to have a plan. It's now too late to talk it over with your Fightergator!! ★

MAJOR BRIAN C. BERNET, CF
Directorate of Aerospace Safety

LOST

...on a circling approach...

Have you ever flown an approach when the weather was down to minimums? Have you had that elated feeling of success, of pride in your ability to make your airplane do just what you want—to perform the perfect instrument approach when it's for real? You probably have if you have done any amount of operational flying.

I expect that most of your approaches in poor weather were precision-type approaches, either ILS or GCA. With these the runway should be at 12 o'clock and rarely is there any doubt about which piece of pavement to land on! However, occasionally a circling approach is required. This means that you do not have the comfort of knowing you are lined up with the landing runway from many miles out. Instead, there may be a frantic search for the proper runway while performing a visual procedure, probably in marginal weather.

If you are unlucky enough to be doing this at an unfamiliar airfield, you may find out what others have found before you; that it is not always easy to find the proper runway for landing.

Not too long ago an IP touched his airplane down on a taxiway. We were fortunate in that case that a tug operator saw what was about to happen and stopped his vehicle instead of entering the taxiway! This is not the first time someone has landed on the wrong part of the airpatch. If we don't keep our wits about us, it won't be the last.

There were perhaps some mitigating circumstances in that case. The taxiway has better contrast with the surrounding environment than does the runway, and the presence of aircraft alongside the taxiway attracted attention to it. However, that airfield is not the only one to cause confusion and the pilot should have been prepared.

There are several basic problems in performing a circling approach to an unfamiliar runway environment; one is the real possibility of choosing the wrong strip of pavement when there is more than one from which to choose. You can prevent this if you check the aircraft heading on final to verify you have the correct runway; just the same as checking runway heading before takeoff to be sure you haven't lost your way taxiing out! Also check the runway numbers to be sure you don't have the parallel taxiway.

There are other things worth remembering about circling approaches. Study the airport layout given on the approach chart before you begin your approach. Don't lose sight of the runway environment; not only can it mess up your approach, but you may be outside your safe terrain clearance limits. Don't bend your airplane too tight around the corners of the pattern. This is for the same reason as flying the proper airspeed. Your flying machine will stop flying if you don't treat it right. If circling at night, remember those beautiful bi-directional runway lights you probably saw as you broke out at minimums. When you get at 90° to them on downwind, you may not see them anymore! So keep alert.

One final word, a circling approach is a visual procedure. As soon as you have joined the normal flight path for a visual pattern, fly your airplane as you would on a VFR day.

Having just alluded to the weather being suitable for contact flight, I realize that it could deteriorate in the latter stages of a circling approach. You should be mentally prepared for reentering cloud and should know in advance what your actions will be. Remember, when commencing missed approach, your first turn should be toward the runway (Reference AFM 51-37, page 15-16). A missed approach from a circling approach may involve a complete reversal of direction, several minutes of flying and considerable maneuvering at low level, which could be in cloud. If a missed approach is possible, have a course of action ready in your mind before you start to circle. Immediately upon going this approach, tell ATC what your intentions are. This will allow them to protect altitude and airspace and maintain separation between you and following aircraft.

Circling approaches are often complicated by poor visibility and other traffic. Not only must you keep the airfield in sight while avoiding aircraft and rock centered clouds, but you must be sure you have picked the proper runway! ★

OH..OH!

WING COMMANDER MARK PERRETT
Royal Australian Air Force
Directorate of Aerospace Safety

When a T-39 lost cabin pressurization while cruising at 39,000 feet, the master caution, cabin pressure fail, and pressure duct fail lights all illuminated and cabin pressure steadily climbed to 39,000 feet.

This occurrence highlights a number of considerations that T-39 pilots should keep close to the surface of their memories:

• When cruising at flight level 390 or higher, remember that a cabin depressurization will leave you, and your passengers, at a height where you need *pressure breathing,* even with a perfectly fitting mask. Not even Super Optimist could consider passenger oxygen masks as nearly perfect fits.

• In such a situation, knowing the Bold Face action is not enough. You need to improve cabin environment *immediately* by initiating an emergency descent (to 25,000 feet).

• Don't wait to receive descent clearance from ARTCC — but tell them immediately that you are descending. Maintain visual flight conditions if possible.

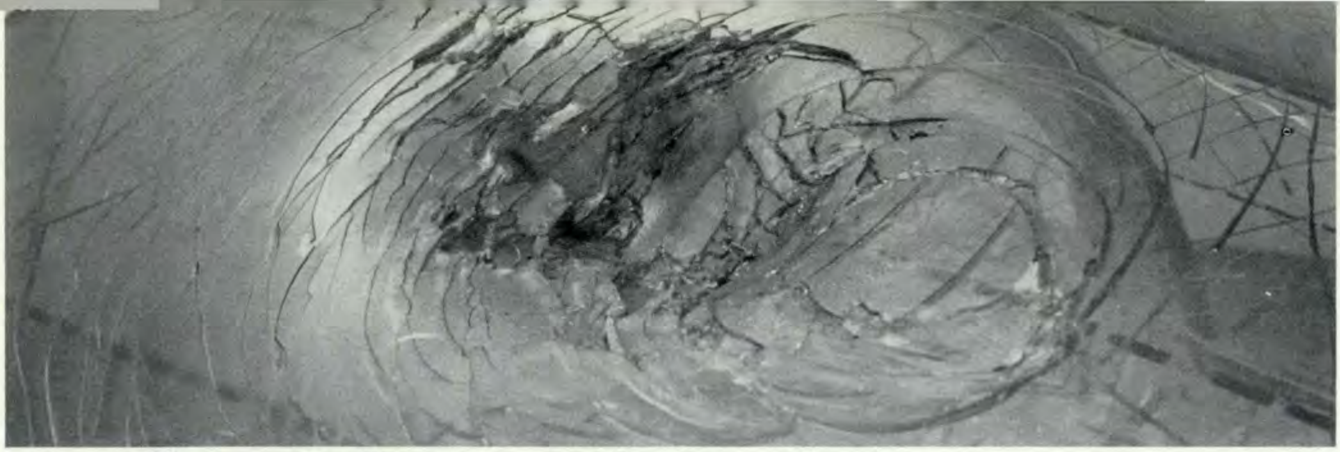
• Consider that 25,000 feet is your maximum altitude available, but a 10,000 foot cabin altitude is preferable. AFR 60-16 Chap 6 para 5b(3) states "descent will be made to a point where cabin altitude can be maintained at or below 25,000 feet." MAC supplements this paragraph to read "descend to 13,000 feet or minimum altitude, whichever is higher." Terrain, navigation aids, flight range, flight conditions and positive radar control (with flight separation) are all factors which may influence your decision.

• The possibility of depressurization should reemphasize to pilots that checking your sweep-on mask is not a gratuitous act—it is vital. Not only does it guarantee oxygen supply when needed, but it will verify that a transmit capability using the mask microphone exists.

• Don't be cursory in your treatment of the passenger briefing regarding oxygen masks. Passengers must have a clear understanding of just what they have to do. You or your copilot may not have time to get back there and monitor their actions.

None of these thoughts is new. They summarize what your thoughts should be on encountering this surprising, and confusing, situation. ★

CONGRATULATIONS—67th Tactical Reconnaissance Wing Commander Col George M. Sauls congratulates Capt Steve Eisenberg (inside L) and 1st Lt Larry Hensen (inside R), while Deputy Commander for Operations Col George R. Hall (extreme L) and 12th TRS Commander Lt Col Dewey K. Hemphill look on.



Crew Protection

LT COL FRANK B. PYNE, Directorate of Aerospace Safety

Cockpit enclosures that provide aircrew protection from bird impacts will be standard equipment on USAF aircraft in the near future. Retrofit programs are underway in some older weapon systems, and new aircraft entering the inventory are equipped with bird-resistant transparencies.

Since 1962, the USAF has experienced 14 major accidents which resulted in five fatalities and aircraft destroyed from birdstrikes which penetrated some portion of the cockpit enclosure. F-111s account for the largest dollar loss with five aircraft destroyed, while T-37s and T-38s account for all the fatalities.

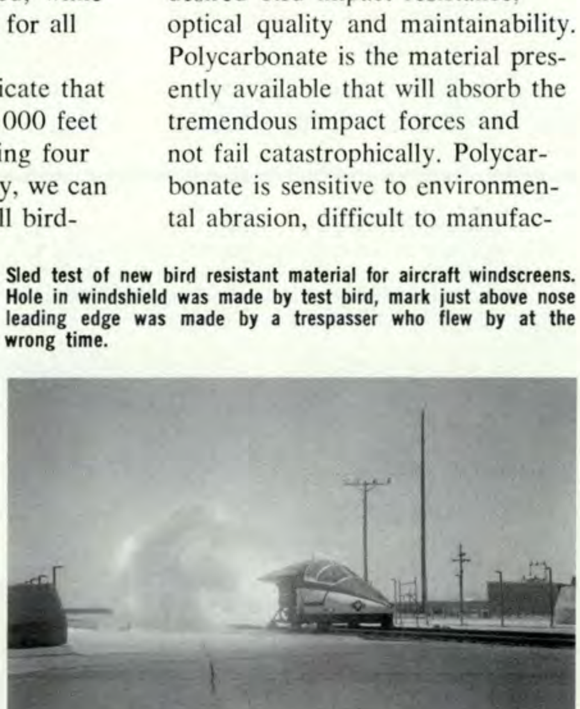
Birdstrike statistics indicate that 90 percent occur below 1000 feet and involve a bird weighing four pounds or less. Statistically, we can expect 11.56 percent of all birdstrikes to be on the cockpit transparency.

In an attempt to eliminate the fatalities and reduce the dollar loss, an extensive R&D program has been conducted to provide protection from birdstrikes for these aircraft. A by-product will be bird protection for all aircraft in the future. Like all things new, some education of the users and maintainers will be required if we are to obtain the benefits and avoid the pitfalls.

Many types of materials were examined and tested to obtain the desired bird impact resistance, optical quality and maintainability. Polycarbonate is the material presently available that will absorb the tremendous impact forces and not fail catastrophically. Polycarbonate is sensitive to environmental abrasion, difficult to manufacture in quantity and cannot be ground or polished to control optics.

To provide protection from environmental abrasion, a scratch-resistant outer layer must be provided. The material used for the outer layer depends on the optical requirements, weight restrictions and the company manufacturing the parts. Glass provides the most protection but adds the most weight. Acrylic is used for some installations, and a thin "hard" coating is used on others. Except for glass, all are subject to surface scratching and cannot be polished to remove surface scratches.

These qualities will greatly reduce service life compared to glass unless both aircrew members and maintenance personnel, are aware of the care and feeding required. With the high cost of replacement parts and industry's present limited



Sled test of new bird resistant material for aircraft windscreens. Hole in windshield was made by test bird, mark just above nose leading edge was made by a trespasser who flew by at the wrong time.

Piece of laminated polycarbonate bird resistant windshield cross section. T-37s are now equipped with windshields made of this material.

capacity to produce aircraft quality polycarbonate in quantity, it is easy to see that we are going to be flying with scratched transparencies or be grounded awaiting replacements.

The same quality that resists bird impacts also makes it impossible to break with a fire ax or canopy breaker tool. Crash and rescue people must be aware of and have the proper tools to saw through the transparency, if required.

In flight, safely behind almost an inch of glamorized plastic, aircrew procedures should remain unchanged from those presently in use. All bird-resistant designs are based on the "catch" principal. That is, to absorb the energy and keep the bird out of the cockpit. This can mean as much as six to eight inches of deflection in the transparency when a bird is impacted at high speed.

Although cockpit enclosures have been redesigned to provide some flexibility for canopy and windshield supports, deflections of this magnitude will dislodge items in the cockpit and reduce the combining glass on optical sights to relatively high velocity debris. Therefore, visor requirements should not be changed. Since the bird cannot always be relied upon to impact near the center of the transparency and the amount of flexibility is limited near the edges, some tearing and bird penetration can be expected if impact occurs near the edge at high airspeeds. Sled tests on F-111 transparencies reduced the bird remains to the consistency of chicken soup. This should be incentive to keep the oxygen mask on if your aircraft is so equipped.

The bird-resistant transparencies will increase the chances of recovering after a birdstrike on the windshield or canopy. Engines are still vulnerable and airframe damage can be severe, so bird avoidance is still the best defense. ★

HYPOXIA

MAJOR BRIAN C. BERNET, CF
Directorate of Aerospace Safety

A review of hypoxia incidents in fighter/attack type aircraft for the period January 1970 to December 1975 reveals the following:

- A total of 40 hypoxia incidents
- Nine in which the cause of hypoxia was not discovered.
- Twenty-nine in which the oxygen flow blinker was functioning correctly but hypoxia occurred before the blinker action was seen to be abnormal.

This leads us to conclude that either the blinker, in aircraft so equipped, was either not checked or the crew did not recognize its action as an indication of an inadequate oxygen supply. Six of these incidents occurred while the pilot was flying in formation, which accounts for less frequent checking of the blinker. In only one incident was improper blinker operation observed prior to the onset of hypoxia.

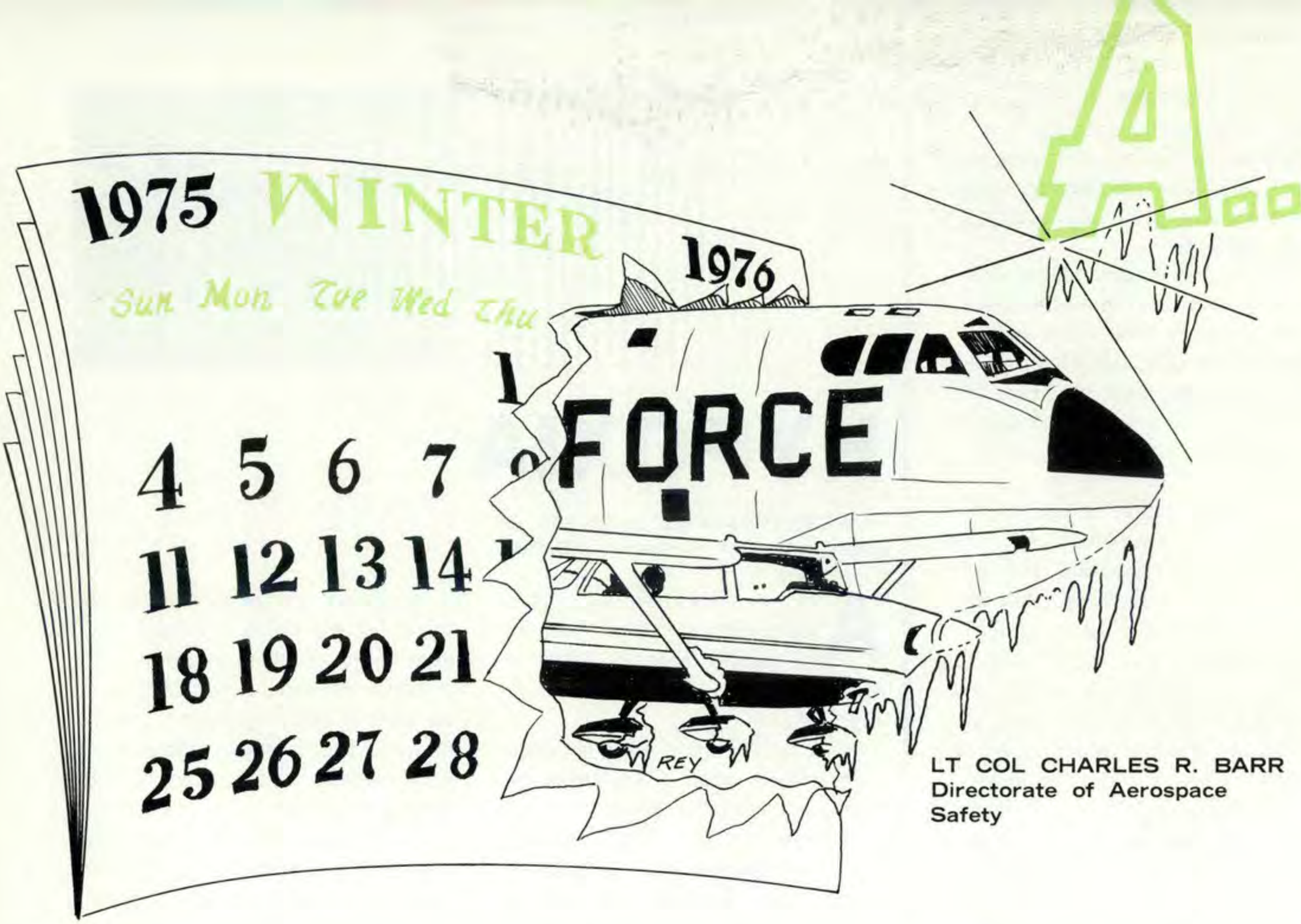
Ten of the incidents occurred while cockpit pressurization was either not operating properly or turned off and cabin altitude was higher than normal. The discovered causes of hypoxia varied from faulty oxygen masks to malfunctioning regulators and leaking lines, and many failures were insidious.

It is worthwhile to periodically remind yourself that in-flight oxygen checks are essential, they must be done conscientiously and they must include frequent blinker checks. It is not good enough to just say the words of the check. Perform each item of the check thoroughly.

Mask fit should be checked to be sure it will not permit leakage at higher than normal cabin altitude. Poor mask fit is often aggravated by turning the head and it doesn't take much of a leak to cause hypoxia. A mask leakage problem usually is not oxygen leaking out but air getting into the mask and diluting the oxygen supply.

One incident occurred in which the pilot inhaled fumes at low level. The significance of this is that after inhaling fumes for a short time, your personal smell detecting system becomes desensitized and it may appear to you that the fumes have gone away when in fact they haven't. If you have selected 100 percent oxygen because of fumes, it is a good idea to stay on 100 percent for a reasonable time, perhaps until landing.

A final word to aircrews should emphasize the importance of knowing how the oxygen flow blinker should respond to normal breathing at higher than normal cabin altitudes. At high altitudes it should be quick and responsive, not sluggish. A very small leak caused by a cracked line, loose connection or mask fit can result in a sufficient loss of oxygen to cause hypoxia. The blinker will probably still blink, but not as it should. ★



LT COL CHARLES R. BARR
Directorate of Aerospace Safety

Jet engine icing has become one of the central topics of discussion in the Flight Safety Division of the Directorate of Aerospace Safety. One could, and should, attribute this interest to a number of startling events that occurred in the recent past. Perhaps this article should have appeared in October or November 1975, but the icing season is still here, and I believe everyone should be continuously aware of the engine inlet icing phenomenon.

It is important that you recognize that all USAF jet aircraft have engine anti-ice, but not all have engine inlet anti-ice. Therefore, you must understand the type and function of the anti-ice systems on the equipment you fly. It is also important that you understand the climatological conditions where engine inlet icing is most likely to occur. Simply stated, the conditions most common to engine inlet icing occur when the free air temperature is between +5°C (41°F) and −20°C (−5°F) and visible moisture is present or the dew point is within 4°C (7°F) of the free air temperature.

Earlier, I alluded to a series of events which precipitated my interest in this article. I must say in researching the historical data, I was surprised to discover that in the time frame I chose (1972-1975) there was only one reported incident in single engine aircraft. NOTE: Historical records reviewed were those contained in the Air Force Inspection and Safety Center's computer file and pertained only to USAF aircraft statistics. Now, this implies that either our single engine jocks are smarter than our multiengine guys (an assumption which I believe is a gross exaggeration), or they are luckier, or they are flying equipment which is less susceptible to engine icing, or they plan better, or they fly in better climatological conditions, or. . . .

Regardless of the rationale you might apply in resolving this dilemma, engine inlet icing is today a more common problem in our multiengine aircraft than it is in our single engine ones. However, this indication will not stand the test of time. To illustrate, one needs only recall a winter deployment of a squadron of F-84s. In the early 1950s, this squadron departed a Texas base on a routine deployment to Indiana. Believe it or not, every aircraft in the squadron experienced engine inlet icing and crashed enroute.

This anecdote aside, what were the recent events? Well, for starters, in 1975 there were 3 aircraft destroyed and 16 lives lost. If that is not enough, how about a four-engine flameout in a B-52 or a $137,000 ice ingestion incident on

PROBLEM WITH ICE

another B-52? There is a story which goes with each one, and I hope by recounting them here they will have some impact.

The first involves a helicopter which departed on a routine mission. The first leg proceeded uneventfully; however, while the bird was preparing for the second leg, a cold front passed through his route of flight. The flight was continued in instrument meteorological conditions (IMC) in areas of high humidity and temperatures of plus 5°C and below for a period of 55 minutes. The pilot then requested a descent to 5000 feet where he reported flight in visual meteorological conditions (VMC). A short time later ground witnesses observed the helicopter making a turn, heard unusual noises and saw the blades were coning upward. Rotor RPM decreased further, and a blade departed. The nose pitched down and the aircraft continued in a vertical descent and exploded on impact. The engine(s) ingested sufficient ice to cause compressor failure and total loss of engine power.

The second and third accidents involve the loss of two attack aircraft. We lost these aircraft from the same unit within minutes of one another. The question generated was why? This is not an easy one to answer because it addresses two problems. The first was the proximity of migrating birds and the second was the danger of engine icing. No matter how you cut it, the pilots were more concerned over the possibility of a bird strike and elected to utilize engine inlet screens. Of course, the problem was that the engine screens iced over, the engines flamed out, and both aircraft were destroyed .

Fortunately, these were the only recent accidents which involved engine inlet icing, and while there were other factors involved, they will not be discussed here. However, in the case of our two B-52s, I'm going to be more specific. If you will recall, in one incident we flamed out four engines, and in the second, we ingested ice in four engines. In one or both cases the pilot may have been at fault—in the former by not maintaining sufficient engine power levels to insure adequate anti-icing, and in the latter by not obtaining a timely update of forecast weather and flying the aircraft into icing conditions that exceeded the engine inlet anti-ice capability.

I don't want to neglect our Aeroclubbers in this article. Consequently, I will include two quick stories for them. Whenever you're flying, don't forget about your carburetor heat. I recall the experience of a friend who was forced to "dead stick" a T-28 into an open field, at night, because he forgot to turn on his carburetor heat. I recall, much more clearly, my own experience which to this day affects my wife's willingness to fly with me—although she really believes I am the world's greatest and safest pilot. On this occasion, we were on leave proceeding merrily on our cross country to visit the folks in a rented Cessna 172. About 20 miles short of our next enroute stop, up jumps one of those nasty Southern Alabama squall lines. I elected to hold, in the clear, west of the line to allow destination airport to clear, when yes, we experienced a little carburetor icing. Sure, the engine ran rough for a few seconds, but nothing more serious happened. No matter, we haven't been on a flying cross country since.

The moral of these stories is that like carburetor ice in a reciprocating engine, turbine engine inlet ice often forms when not expected. One bank of clouds may not cause icing while another, which to all appearance is exactly the same, may. Remember, once inlet ice commences to form, an appreciable accumulation can build up with startling rapidity; when visible moisture is present, engine inlet icing can occur over a wide range of temperatures, above or below freezing. The increase in air velocity as air enters the aircraft engine duct, the engine compressor inlets, and the compressor inlet guide vanes cause a drop in the temperature of the entering air. Moisture in the air becomes super cooled as it passes through the engine inlet and it can cause engine inlet icing even though external ice is not being formed on the aircraft.

What I have attempted to do in the limited space of this article is to present a concern. Hopefully, that has been accomplished. However, before I retire this flowing pencil, let me reflect an opinion. The recent history of mishaps which involve engine inlet icing, presents a rather damning indictment of our pilots. There are few missions in a peacetime Air Force which are so critical that your judgment should ever be questioned. Know your equipment. Know your capabilities. ★

MAIL CALL

1. It is assumed that the FOD problem will continue to plague our flying activities until a new system of propulsion is devised to replace the jet engine. And, like any product, new ideas and creative salesmanship must be foremost in our approach to selling the solution.

2. I feel that "FOD" is an after-the-fact approach. We recognize dynamite as an explosive force, but we do not commonly refer to it as an "explosion" or a "hole in the ground." For this reason, and to gain a little more positive attitude towards a solution, the following article is submitted for publication:

FOD: What is it? It looks like nuts, bolts, screws, wire, rocks, and small metal parts. Simply stated, it is scraps or litter not placed in a proper waste receptical. Some states assess $500 fines for littering; however, the Air Force has no fines even though ingestion of this trash can cause a $180,000 engine loss. FOD is really a misnomer for normally it does nothing except just lie there insidiously waiting to become FOD. What we really need is a new *acronym* for all this junk, BEFORE THE FACT, like maybe, "PIU" (pick it up).

PAUL G. KREY, Colonel, USAFR
Deputy Commander for Operations
442 Tactical Airlift Wing (AFRES)
Richards-Gebaur AFB, MO

A contradiction appeared on Page 2 of Nov, 1975 issue when it states "transponders are required by law to be on all aircraft operating in controlled airspace. This is in error. . . ."

JOHN M. MILLER, Capt, USAFR
Grd Safety Officer/FAA Accident
Prevention Counselor
305th Aerospace Rescue &
Recovery Squadron (AFRES)
Selfridge ANG BASE, MI

In our article "Contradictions in Midair Collision Prevention?" (Nov 1975), we stated that transponders were required on all aircraft operating within controlled airspace. That was wishful thinking on our part. However, you must have a transponder with altitude *reporting:*

a. Above 12,500 feet MSL (excluding airspace at and below 2500 feet AGL).

b. Within a Group I Terminal Control Area.

Within a Group II Terminal Control Area you must have a transponder, but Mode C, altitude reporting, is not required.

Transponders are not required for IFR flights operating to or from airports located outside of but in close proximity to the TCA and transition routes pass through the TCA.—Ed.

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UNITED STATES AIR FORCE

Well Done Award

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

Captain JAMES D. THOMPSON

First Lieutenant VIC A. SORLIE

366th Tactical Fighter Wing
Mountain Home Air Force Base, Idaho

On 8 April 1975, Captain Thompson and Lieutenant Sorlie were flying an F-111F training mission at low altitude when the aircraft struck a large bird. The radome was destroyed and pieces slammed into the windscreen, shattering the right side section and pulling the glass panel loose from the frame for 14 inches. Captain Thompson immeately disengaged the auto terrain following radar, swept the wings forward, climbed to minimum enroute altitude and reduced airspeed. Because of adverse weather, he requested a rendezvous with another F-111F and made a successful return to base. After a conference between the crew, commander, director of operations and the manufacturer's experts, the decision was to fly a no flap, no slat approach to avoid the possibility of failing the windscreen. Despite limited forward visibility, Captain Thompson made an uneventful landing. Close crew coordination, professional judgment and careful analysis of the emergency enabled the crew to recover a valuable aircraft. WELL DONE! ★

Can You Identify These Men?

THESE MEN ARE:

- ☐ A. Members of a United Mineworkers local in Pasquahatchuie, KY
- ☐ B. Members of the SAC underground command post out for a smoke
- ☐ C. Waiting for their car pool
- ☐ D. Itinerant flyers making their way through China
- ☐ E. In the primary zone for the next promotion cycle
- ☐ F. Reunion of the USAF Academy Class of '42

Answer

The correct response should be D. Itinerant flyers making their way through China. These are the crew members of the famous Doolittle's Raiders after having crash landed in China following their thirty seconds over Tokyo. The story of that raid, with historic photos from the Air Force Museum, will appear in the April issue of AEROSPACE SAFETY.