aerospace

SAFETY FEBRUARY 1977

From Phantom To Eagle

page 2

Cover photos courtesy
McDonnell Douglas Corp.

UNITED STATES AIR FORCE FEBRUARY 1977

aerospace SAFETY

THE MISSION - - - - - - SAFELY!

SPECIAL FEATURES

REGULAR FEATURES

NAME THAT PLANE

THE C-125 RAIDER (1949)

The Northrop C-125 Raiders were three-engined transports built to operate from improvised airstrips as airborne assault vehicles and rescue aircraft. Twenty-three were ordered by the USAF, thirteen as Assault Transports and ten as Arctic Rescue aircraft. The C-125 had a nearly rectangular fuselage to give maximum cargo space and an under-fuselage ramp cargo door to permit the loading of vehicles. These transports were powered with three 1200-horsepower Wright R-1820 engines, each driving reversible propellers. The wingspan was 87 feet, length 70 feet, weight loaded 32,500 pounds. Wheel and ski equipped for operating either on snow or on normal runways, these airplanes were used primarily for Arctic rescue. First assault-rescue type aircraft designed for snow/ground landings with its wheel-ski equipment.

DEPARTMENT OF THE AIR FORCE • THE INSPECTOR GENERAL, USAF

FEBRUARY 1977 AFPR 127-2 VOLUME 33 NUMBER 2

Readiness

The Chief of Staff designated 1976 as Readiness Year. A most appropriate emphasis in the face of the serious massive shift in the world balance of power over the past decade. Where once the United States was the world's foremost military power, we find ourselves today in a position of approximate equivalence to the Soviet Union. As a free people we tend to neglect defense when potential adversaries are not dramatically threatening our freedom. Thus we have been experiencing repeated reductions in the purchasing power of our defense budget, while the USSR has been dramatically expanding their capabilities as well as refraining from certain of the more flamboyant world acts of provocation which alert democracies to their real objectives and stir our defensive efforts.

What has this to do with Safety and accident prevention? How can we as safety persons contribute to increased readiness? I think the answers are clearly obvious. Our most difficult challenge is how. In 1976 we developed the capability to predict, within a very few percent, how many accidents we would have, which aircraft they would involve and what categories the cause factors would fall into. Encouraging, yes, but at the same time frustrating in that we were subsequently unable to lower the number of these occurrences or significantly change the reasons for them. That was not because all of you did not work hard or were not dedicated to the task, but because we have yet to learn how to effectively and dynamically translate lessons from the past into preventive actions of today, to create a lower experience for tomorrow.

We continue to lessen our potential effectiveness by inhibited communications. In certain instances we appear to be more concerned with our rates than with our real efforts to enhance readiness and maintain the highest combat capability. We hate to be told we've made a mistake or overlooked a rather obvious fact, or followed a faulty logic path, or failed to fully recognize and support someone else's needs.

The cost of aircraft accidents last year approximated the cost to operate an average Air Logistics Center for that same period. The cost of all accidents has, on occasion, approached the level of funds authorized by congress for all modifications to our weapon systems.

Unquestionably our job can have a serious and direct impact on readiness and total combat capability. It is up to each of us to influence those for whom we work —functional managers, and decision makers at all levels—to properly include the safety factor in the management and operational decision equation. We can no longer demand safety for safety's sake alone. Ours must be a studied, unemotional and fresh approach to what is needed to make our weapons systems effective, functional and long lasting. Together we can make 1977 a truly outstanding year in terms of reducing accidental losses. ★

RICHARD E. MERKLING, Maj Gen, USAF
Director of Aerospace Safety

FLYING THE EAGLE

MAJOR THOMAS C. SKANCHY, 555 TFTS, Luke AFB AZ

After spending nearly a decade in the Phantom, it would be down right dishonorable, not to mention unthinkable, to degrade that superb fighter when comparing it to the F-15A Eagle. Without treading on anybody's toes or injuring the pride of those who care for or fly the Phantom, allow me to make some observations on my impressions when stepping out of one outstanding fighter into another.

For those who haven't had a glimpse of the finest fighter in the world, a quick synopsis of the Eagle would be in order. The F-15 Eagle was designed and developed for one sole purpose, air superiority. True, it has outstanding secondary capabilities too, but let's stick to the primary role.

It is a single-place, fixed wing, Mach 2.5 class twin-engine aircraft that can outperform and outfight any enemy fighter aircraft in the foreseeable future.

The F-15 combines the most advanced fire control system with Sparrows, Sidewinders and gun for optimum combat efficiency, and is capable of carrying conventional ordnance without off-loading any of its air-to-air missiles.

The low wing loading and an excellent thrust-to-weight ratio provide the F-15 with unprecedented maneuverability.

These features, combined with

an advanced electronic system to sort and identify targets and to evade enemy defenses, enable the F-15 to find, identify, engage, and destroy any aircraft expected to be a threat through the 1980's.

Being assigned to the F-15 at an early stage of its introduction to TAC was in itself a very unique situation. To quote the instructor after my first flight in the two seat TF-15, "Now you know everything about the F-15 that I do." The point was that we were in virgin territory, operating the aircraft, not to mention the yet-to-be-developed tactics and concepts for the application of the Eagle. I don't know if I was apprehensive because I was leaving my best friend, the Phantom, for a strange and unfamiliar aircraft, the Eagle, or if I was apprehensive because seemingly the whole world appeared to be watching my every move as a new guy in the F-15. Anyway, I was plenty apprehensive.

Hitting the books was my first order of business before actually setting foot in the F-15. I'll never forget the incredible number of acronyms used with the bird. They seem to sprout out of everything like undergrowth in the jungle. I wore out three glossaries trying to figure out what, for example, JFS, HUD, CC, CDIP, DIL, and FOV stood for not to mention HPRF, IRE, and TEWS. I still find my memory fails me when trying to explain something in the cockpit once in awhile and have to revert to point at that "what a ya call it."

My first flight is etched indelibly in my mind. Could an old dog be taught new tricks? That saying kept going through my mind again and again. The crafty crew chief watched my every move through narrowed eyes as I preflighted his aircraft. He had adequate clues that this was my first flight when I hit my head twice during the preflight and took ten minutes, even with his help, just to strap in. This particular "Eagle Keeper's" name was Sgt Yaple (recently returned to civilian status). I know that Sgt Yaple was sure that his aircraft would never be the same again after I got through with it.

As most of you know, the F-15 has self-contained starting capability. In fact, that is the only way you can start it. The Jet Fuel Starter (JFS) is started by stored hydraulic pressure accumulators. I know the biggest fear of Sgt Yaple (and any other crew chief for that matter) is that the pilot will forget to turn the JFS starter switch on and deplete the JFS accumulators. It takes 400 strokes with a breaker bar to replenish the accumulators if the pilot "screws up" and that is quite a muscle building program, to say the least. Much to my relief and to Yaple's surprise, I started the Eagle without incident, got through all of the seemingly endless pre-taxi checks and got out of the chocks.

With the narrow gear, the bird feels a little spongy at first. The brakes grab a little until you get used to them, but the one item that

The F-15 has a self-contained starting capability. The Jet Fuel Starter is actuated by stored hydraulic pressure accumulators.

Photos from McDonnell Douglas Corp. and TSgt Herman J. Kokojan, formerly assigned HQ AAVS Photojournalism Division.

High idle thrust moves the F-15 right along. Pilot must use brakes continuously to avoid taxiing too fast.

really gets your attention is the idle thrust. Your first impression is that you're taxiing with military power. In this aircraft, you must continually ride the brakes. If you don't, you'll reach a terminal velocity at idle thrust of somewhere around 70 knots.

The first afterburner takeoff is the best. Normally, we do a mil power takeoff, but on this flight, I got to perform a maximum performance climb. I'll tell you, when you plug in those burners the Eagle literally leaps into the air. My first impression was to get the gear up before I sheared them off with the rapid acceleration. A nice four "G" pull puts the bird in a breathtaking 70 degree climb. I will never forget or ever get tired of the "elevator effect" you get when doing a maximum performance climb. It is fantastic to be at 20,000 feet by the end of the runway or maybe a little beyond.

The turn rate and ability to sustain energy really gets your attention. You can haul back on the "pole" at all altitudes at all airspeeds and get lots and lots of G's. Flying around at five, six, or seven G's for two or three minutes at a time can make you want to cry uncle. The younger jocks think they do better at this than us older guys (I'm 37). After a good engagement against a Captain in his twenties, I find that those nearing the middle age can give a pretty darned good accounting for themselves. I found the secret is to keep the younger guys looking over their shoulders.

The avionics are really a quantum jump. The Hughes built pulse doppler radar, a central computer, armament control panel, radar display, and the heads up display are really the heart of the aircraft. It takes a lot of dexterity, a sound knowledge of intercept basics, and good tactics, but the F-15 can whip any aircraft it will run against in the air. One man can more than handle the avionics in this radar. Put an aircraft out there someplace and the Eagle can detect and intercept it at any range at any altitude. Target detection as far away as (I must censor this but it is long range) is very common. Crop dusters are regularly detected and locked up coming back from the air-to-air ranges.

Landing the bird takes a little different technique from the F-4. Instead of just driving it into the runway, you pull the power to idle and flare the aircraft holding it off until it smoothly touches down. You then hold the nose off for aerodynamic braking until about knots. Landing rolls can be very short. It lands just like a Cessna, to be quite frank about it.

We have flown many VIP's since we got the Eagle at Luke. Air Chief Marshall Smallwood of the RAF told me after taking him for a ride that "The Eagle handles just like a Spitfire." Now I know that he just paid the F-15 the finest compliment any fighter pilot could pay an aircraft. I am sure he meant every word of it too.

Back to my first flight. I got the bird back on the ground without incident but made the normal new guy mistakes. You know, I missed check list items, I couldn't find the flap switch, and I couldn't remember the radio calls. Sgt Yaple was there to signal me into my parking spot. He looked a little like a runner in the starting blocks— ready to take off running. Probab

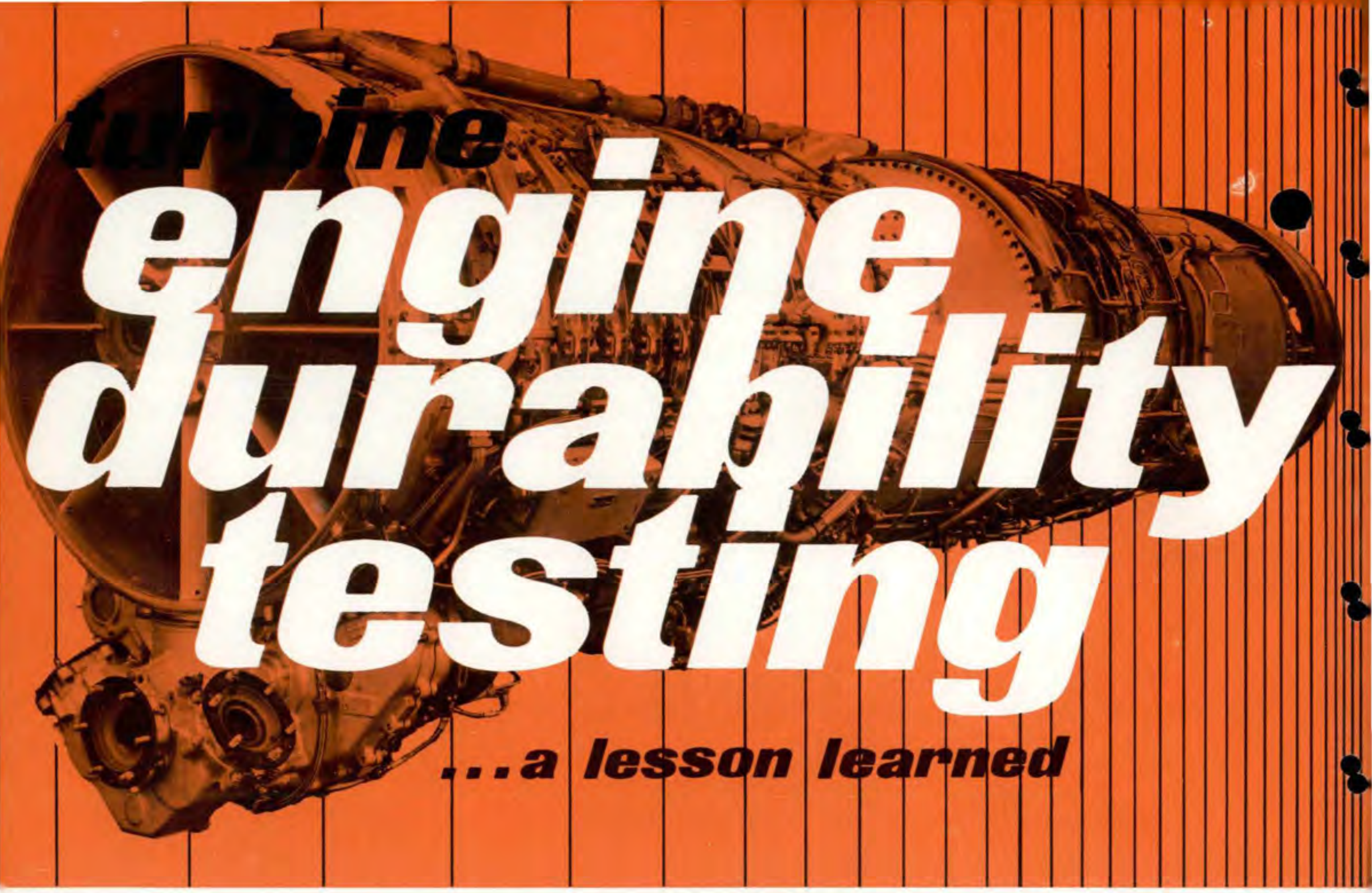
he was a little afraid I couldn't find the brakes. We post flighted the aircraft together. Only after confirming the landing gear was not bent at some new angle and that the tail hadn't been scraped, did Sgt Yaple smile and shake my hand. My IP, Lt Col Gene Thweatt, put in my grade book something I really felt after that first flight, "Welcome to the Eagle."

And for you Phantom jocks let me tell you the best kept secret that we ex-Phantom jock-now-Eagle drivers have. The Eagle is easier to fly than the Phantom. ★

ABOUT THE AUTHOR

Major Skanchy entered the Air Force in 1962 and took his pilot training at Williams AFB AZ. He spent his first three years instructing in a command other than TAC, and has also served in Korea, Japan and Vietnam flying the F-4 Phantom. He was assigned to the initial F-15 cadre, and is currently operations officer in the highly respected and world famous 555th TFTS "Triple Nickel". Major Skanchy has over 4,000 hours flying time.

turbine engine durability testing ...a lesson learned



CAPTAIN THOMAS A. STEIN, Aeronautical Systems Division, Wright-Patterson AFB OH

Accelerated mission testing, based on actual operational usage, is a valuable tool which can lead to safer, more durable engines.

In the Air Force acquisition/development arena, there is a continuing need to glean lessons learned from our past development experiences and use this knowledge to better accomplish our present and future development tasks. In this regard, aircraft gas turbine engines are receiving greater scrutiny than any other aspect of our new aeronautical systems. This results from a noticeable increase in the incidence of aircraft turbine engine failures and from operational and support costs for recent developments that are much higher than originally anticipated. There are a multitude of reasons, and a thorough discussion of all cause factors is obviously beyond the scope of one article. However, this article will address one of the more significant and universally accepted lessons that is being learned: that *accelerated mission testing,* based on actual operational usage, is a valuable tool which can lead to safer, more durable engines.

This article should be of interest to operators because it discusses (1) the nature of engine durability problems; (2) the impact usage can have on engine durability; and (3) how accelerated mission tests are constructed and used to improve turbine engine safety and durability.

For any engine development program, there is a strong need to devise an engine endurance test which will reveal structural durability problems. These are insidious problems that generally show up only after long term engine operation. Their very nature makes them difficult to uncover. Further, structural durability can involve a number of failure modes. For instance, blades, disks, spacers, shafts, and even cases may be sensitive to metal fatigue (termed Low Cycle Fatigue—LCF) and fail after a period of successful service. In the engine hot section, turbine blades may be sensitive to the combined effect of sustained stress and temperatures and fail in a creep or stress rupture failure mode.

Blades are also especially sensitive to a vibratory failure mode termed High Cycle Fatigue (HCF). Engine components may also be sensitive to other forms of long-term degradation such as erosion and wear. The point is that engine components are subjected to various, complex, and many times interactive failure modes. This fact makes these long-term durability problems difficult to uncover. Because even the most advanced analytical techniques fall short, a realistic ground endurance test becomes critically important for assuring long-term engine flight safety. It is easy to be misled; the idea is not to over test or under test but to test in such a manner that test inputs and consequently test results will have a close correlation with actual service.

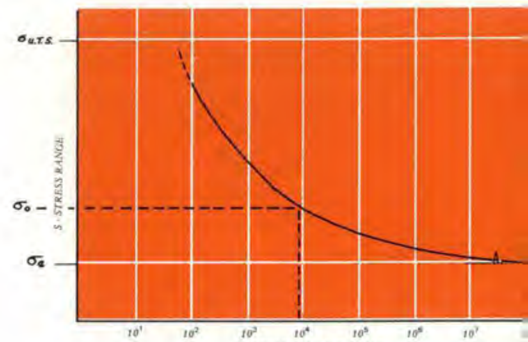
In the propulsion development community within Aeronautical Systems Division (ASD) at Wright-Patterson AFB, a conscious effort has been made to evolve a realistic engine durability test by carefully considering what drives engine durability. This has led to a new approach and a significant departure from the traditional 150 hour qualification test which is arbitrarily defined by specification. This approach is termed *Accelerated Mission Test* (AMT) and is being applied to various engine models within ASD purview. It is proving to be a valuable tool for identifying and preventing engine durability problems. This experience has proven to be a valuable "lesson learned." Further, it has important implications for operational personnel because throttle movement can have a big impact on engine durability.

ENGINE DURABILITY

Many engine components are durability or "life limited." The amount of life capability a part possesses is determined early in an engine design and is a function of operating stress levels, material characteristics, temperature, and design details. However, actual engine usage, specifically throttle movement, determines how rapidly this finite life is consumed.

LOW CYCLE FATIGUE—LCF

Both the frequency of movement and the magnitude are significant for LCF damage. These movements produce changes in centrifugal stress for rotating parts, due to changing spool speeds, and also produce thermal stress, due to changing temperature levels for each part. These stress excursions or stress cycles produce fatigue damage which can result in failure. This concept is best visualized as shown in Figure 1 with the stress range vs cycles, or SN curve. Higher stress excursions result in lower cyclic life. Point A represents a stress level below which infinite cyclic life exists. In reality, very few components are stressed at this low level, hence, most have a finite fatigue life capability. Throttle movement magnitude is not constant, and Figure 2 is provided to show typical relative LCF damage contributed by various throttle movements for particular classes of parts. This assessment is based on a detailed stress analysis of each part and shows that in addition to the O-max-O cycles, idle-mil-idle cycles are damaging. This is particularly true of low spool components in a turbofan and results from the large speed range the low spool experiences. It should be apparent the LCF is particularly a problem for fighter type engines in view of the relatively low life capability (high stress levels for high thrust to weight ratio) and relatively high throttle usage or damage accumulation.



σ_e = STRESS LEVEL BELOW WHICH PART HAS INFINITE FATIGUE LIFE

σ_o = TYPICAL DESIGN OPERATING STRESS LEVEL - PART HAS FINITE FATIGUE LIFE

FIGURE 1: TYPICAL SN CURVE

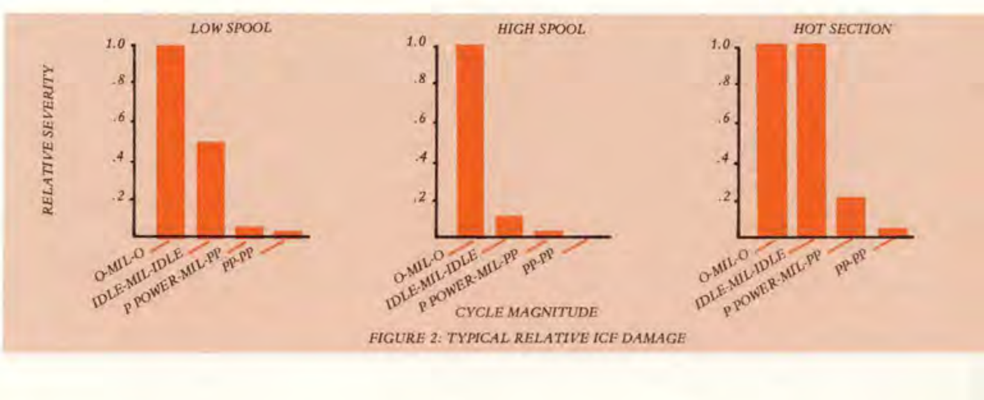


FIGURE 2: TYPICAL RELATIVE ICF DAMAGE

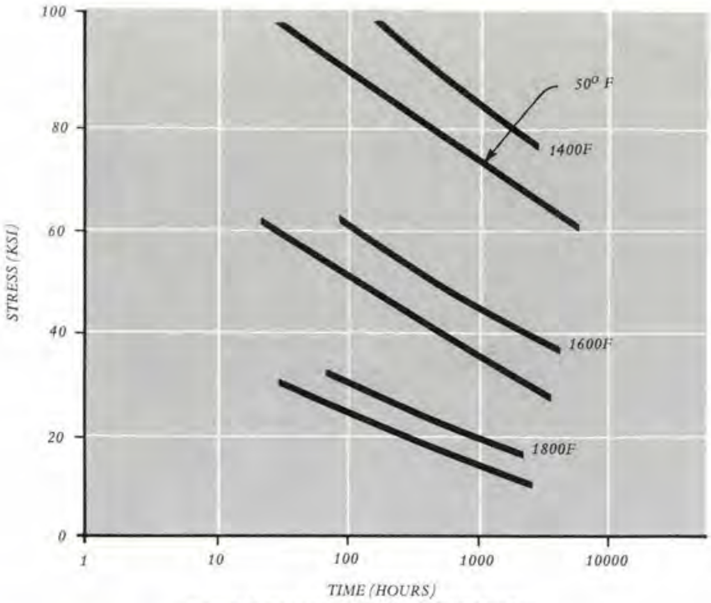


FIGURE 3: EXAMPLE STRESS RUPTURE DATA

STRESS RUPTURE

Time spent at high engine power setting results in sustained stress at high turbine temperature for engine hot section parts. Some parts (principally turbine blades) have a high temperature life which is finite. Figure 3 shows typical stress rupture data plotted against variables of stress, temperature, and time. Time spent above a threshold turbine temperature (generally corresponding to maximum continuous) consumes this finite life. Therefore, operational usage with extended periods of operation at max power also hurts engine durability. It should further be noted that an interactive effect between fatigue (cycles) and temperature effects (hot time) may exist. For instance, a turbine vane may develop cracks in LCF driven by cycles and then erode as a function of hot time. This factor makes it especially important that durability simulation tests contain these effects in the proper proportion.

AMT—TEST SET UP

The following discussion explains how this insight concerning engine durability has been used to develop Accelerated Mission Tests. These programs are uniquely modeled for each engine model and begin with a detailed knowledge of actual engine usage, i.e., how you guys use the throttles. This information is generally obtained through extended visits to field operating locations to discuss flight and ground operation with operational personnel.

Throttle movement in terms of power lever angle (PLA) or per cent rotor speed is characterized against time for all missions within the total mission mix. From these data, a representative flight test cycle is derived which simulates an average flight sortie. Similarly, a representative ground operation test cycle is derived which simulates damage imposed during ground operation, principally test cell and trim pad. These test cycles contain the damaging events, large throttle movements and time at high temperature, as they would occur in service; however, the relative undamaging small throttle movements and time spent at part power are deleted, creating an accelerated test cycle. An example is shown in Figure 4. This is both an economic compromise in view of engine test costs and also allows years of representative damage to be imposed in a relatively short period of test time.

These tests are generally run in a sea level test facility; however, this will depend on service usage. It may be necessary to conduct a portion of the test in a pressure altitude test facility so that stress and temperature effects can be properly duplicated. This is particularly true for high mach number operations. Once test conditions and test cycles are established, representative flight and ground cycles are run in a

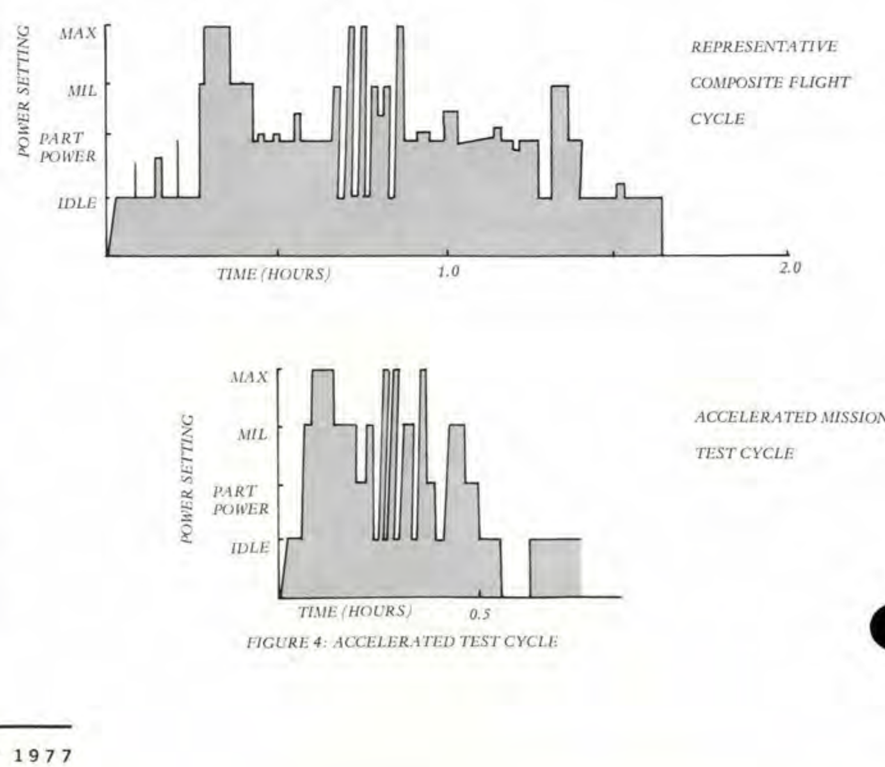


FIGURE 4: ACCELERATED TEST CYCLE

proper sequence such that actual service usage is simulated in test.

It should be evident that the success of this approach is dependent on whether test experience correlates well with actual service experience in terms of type and degree of hardware distress. Experience to date has been very encouraging. Figure 5 summarizes various engine accelerated mission tests being conducted within ASD purview today. Where possible, accelerated mission test engines are torn down for analytical inspection and comparison with *lead the force* service engines at an equivalent service exposure. An example of this correlation is shown in Figure 6.

These turbine vanes were taken from test and service engines at an equivalent number of service hours. These results are indicative of the good correlation between test and service being experienced. In some cases, this type of test has successfully duplicated known service problems that could not be duplicated in years of previous factory test experience. In other cases, durability deficiencies have been uncovered through AMT well in advance of the force so that orderly, timely redesigns can be effected with minimum operational impact. The success of this approach has proved to be a valuable "lesson learned" and provides the development community with an important management tool for identifying problems early and correcting them before they can become serious field problems.

SUMMARY, SPECIFIC ACCELERATED MISSION TESTS

ENGINE	*USAGE SURVEY*	*TEST ARTICLE(S)*	*NOMENCLATURE*
TF41	*OCT 74* *OCT 76*	*142072* *908*	*SIMULATED ACCELERATED FLIGHT ENDURANCE (SAFE)*
J85-21	*NOV 74* *JUL 76*	*225L05*	*LCF ENDURANCE TEST*
F100	*APR 75* *JAN 76*	*FX207* *PX273* *PX 438 (F-16)*	*ACCELERATED OPERATIONAL MISSION TEST (AOMT)*
TF34	*JAN 76*	*0027* *0025* *0015*	*SIMULATED SERVICE TEST (SST)*
F101	*PROJECTED USAGE*	*0019*	*LIFE CYCLE TEST (LCT)*

FIGURE 5

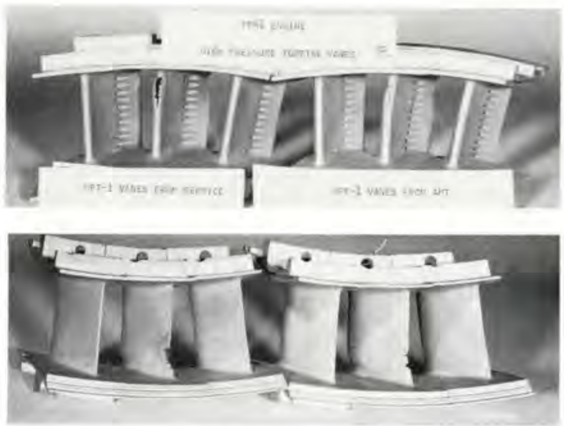


FIGURE 6

USER—IMPLICATIONS

This "lesson learned" also has important implications for operational personnel who have their hands on the engine throttles. Engine durability and engine usage are keenly tied together. Consequently, the engine development and logistics support communities must understand how our engines are being used. You might note that our most advanced engine developments have unique engine instrumentation for counting cycles and recording time above discrete temperature levels. This information is used for defining and tracking engine usage and will help us do a better job of structural life monitoring. This experience also says that your throttle movements do make a difference. Given a choice, the number of throttle cycles, the magnitude of cycles, and time at high power should be kept to a practical minimum to extend engine structural life.

AMT—IMPORTANCE

Since equivalent service hours can be accumulated by test in a short period of calendar time, AMT provides a means of looking out into the future and identifying problems before they cause serious safety, economic, and operational impacts. This approach can be used to screen engine designs for their intended service life and provide greater assurance of engine structural integrity. Additionally, the results of AMT can be used to establish more realistic parts reject/overhaul criteria and a more stabilized logistics support environment.

In sum, AMT can improve engine flight safety and can help lower engine operational and support costs. This means less risk of engine failure and better durability characteristics for the operational community. AMT has been written into our advanced regulations and standards governing the engine acquisition process and the concept has become an integral part of our newest development programs. ★

SOME COMMENTS ON....

WIND SHEAR

MAJOR DAVID C. CARTER
132 TFW, Iowa ANG

"Rapid 21, turn left to 330° and intercept the localizer at or above 2600 feet. One mile from the marker, cleared for the ILS approach to Three Zero Right, contact Tower 257.8."

"Rapid 21, roger, cleared for the approach." (You weeney—I'm 6 months from my last bag ride in weather, and you give me a 1-mile turn-on with a 30° intercept. . . . gear, flaps, landing light. Here comes the localizer off the stop; bank left, pitch changes to hold altitude as speed decreases and flaps come down . . . roll out, catch the IAS with power at 170 KIAS, the glide slope is already in the center, lower the nose and pull a bit of power, turn back right for the first cut at wind correction—I'm already a dot left.

Passing 1800 for a DH of 1160. Vertical Velocity is about 700 and holding half a dot low—super! Localizer's going left, dip left wing a moment and level out—localizer is almost still now. Add a bit of power —5 knots slow, there goes the localizer again. There goes the glide slope almost a dot low—gotta stop that—add a tad of power and raise nose a dot. Gadzooks! Near 2 dots low and going fast!

Full power and raise nose 4 degrees. And I'm 10 knots slow. There it comes—one dot low and going to center, lower nose a bit. Now I'm 10 knots fast—back on the power. Dang localizer—forgot to keep it trapped during that glide slope crisis. DH, there's the field, jink right and left, dip a wing and opposite rudder for the crosswind . . . touchdown.

Home free again! . . . rollout . . . clean up the cockpit . . . taxi back. . . . I wonder if the ILS glide slope transmitter fouled up momentarily? I'm sure I had that V/V and glide slope wired. How could I have gone so low so fast? Full dang power and really had to haul the nose up to stop that beauty! Lucky it was me and not some young flack-bait new guy—he would have sunk into the trees for sure. . . . mumble, mumble. . . ."

Voice from nowhere:

"Hey, hero! Yeh, you—the guy taxiing back talking to yourself. You always do that—talk to yourself? What's that? You also read to yourself? *Playboy,* no doubt."

"By chance, did you happen to read *TAC Attack* for Sep, Oct, and Nov 1976? The three-part series on low level wind shear might give clues to the answers to those hard questions you're asking yourself.

Pay attention while reading the articles and remember: If you don't learn something from every flight, you're over the hill."

(Comments overheard in the pilots' lounge two hours later.) Those articles were good—not the pointy head stuff you might expect from a non-flying weatherman or a safety guy playing Halloween spook (trying to scare everyone but not being very realistic). Look at Part I, the last paragraph, where it says, ". . . an aircraft can, in a matter of seconds, descend into a zone where wind direction/speed is substantially different. . . . the pilot may not be able to accelerate or decelerate . . . rapidly enough to prevent a substantial effect on aircraft performance. A successful recovery may range from being physically impossible to highly dependent upon immediate corrective action by the pilot."

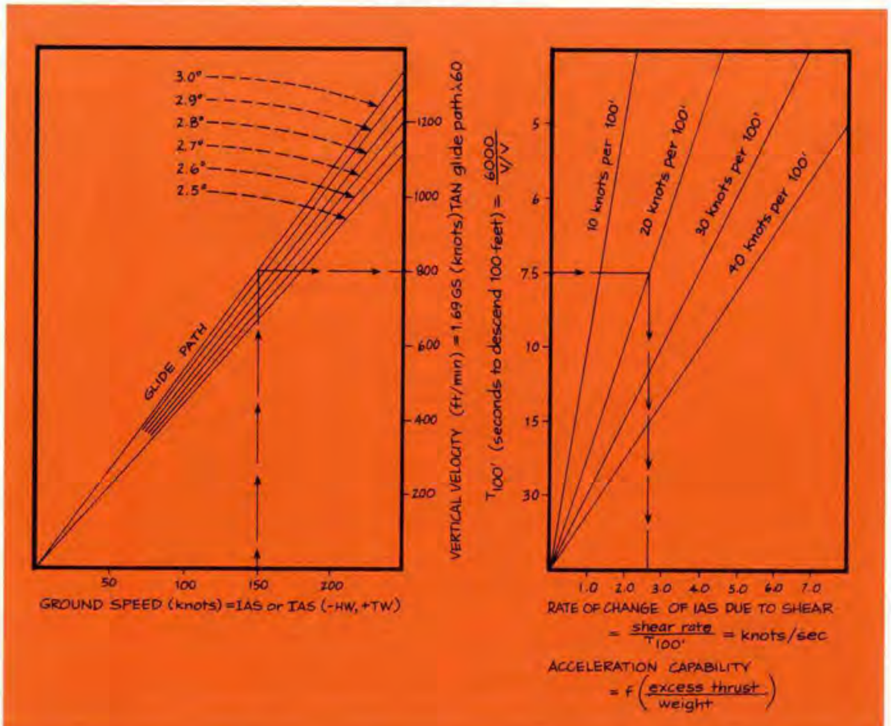
Boy! Does that sound familiar! I hacked it today, but it wasn't hot and I was at normal landing weight and had good acceleration capability. And I was fairly aggressive in correcting. Even so, I still had full scale below the glide path for an instant. Also, the article hit another nail on the head: A pretty good cold front had gone through within the hour. Maybe I did experience the effects of wind shear. On the other hand, my cross-check and reactions were slower than my normal "superior" level. But I find it hard to believe that I got that low all by myself, even if I haven't had as much instrument practice recently as I'd like.

Part II of the series covers in fine detail the specific effects of shear on the aircraft. It is really eye-watering to think of the percentage decrease in lift that a shear can cause. Using an F-100 speed of 170 IAS/TAS and assuming the loss of a 20-knot head wind, I'd lose 22%—1/5th!—of my lift if the speed change occurred instantly.

Some pilots who scanned Part II balked when they came to the sentence on page 19 that said, ". . . the Indicated Air Speed (IAS) will drop instantly by the amount of wind shear." It was worded better in Part I, as quoted just above. But, to defend the author and support the overall excellent effort to help us pilots, the graph below shows in exact terms just how fast the IAS will change. It is true that it doesn't change instantly. If there's a 20-knot shear in 100 feet of descent, and it takes 7-to-10 seconds to descend 100 feet, then IAS changes at 2.8 to 2.0 knots per second, respectively. That's not instantly—but it isn't slow either!

Consider the F-100 on a hot day with full internal and 500 lbs still in each tank on the first practice instrument approach: Before starting down the glide path, if the pilot gets 10 KIAS below the full flap final approach speed he'll have ZERO excess thrust available for acceleration. I've seen two pilots have to lower the nose for a moment (unload and extend right on final approach!), just to regain speed. They

FIGURE 1



only went down 100 feet but the example illustrates how little excess thrust was available on those occasions. Going down the glide path, the power is back about 3%. Now throw in the wind shear: 3% is all that's available to accelerate the aircraft nearly 3-knots per second. That airplane *is* going to slow down or descend or both until enough time has elapsed to slowly accelerate back to steady state flight. During that time the pilot has his hands full.

Is there a situation where the aircraft's IAS will change instantly? I think so. I recall an early morning mission during UPT at Williams AFB. The objective: Practice SFOs. I'd done well on similar sorties previously. The first pattern was looking near perfect and my IP was relaxed—until hard stall buffet and my burst of throttle jarred him into wide-eyed attention. We were still approaching the runway threshold at maybe 30 to 50 feet in the air. "Too far out to be going so slow, dumb student," my instructor's glare and muttering implied. It happened once or twice more. The debriefing later was quick, contained more comments about judgment, and left us both feeling an uneasy discontent.

"Weather" was slated for afternoon academics, and—you guessed it—wind shear was one of the topics. A call to the base weather station later in the day reinforced my suspicions—I had been "had" by shear that morning and neither the IP nor I had recognized it.

Most people who have flown in the desert recall the early morning drives to work: The wind is dead calm, the smoke goes straight up to double or triple the height of a house, then goes horizontally. That's probably as close to an instantaneous shear and change of IAS as you'll find anywhere.

Back to the series in *TAC Attack*. Part III looks at methods of warning pilots that they might encounter shear, then talks about what the pilot can do if so warned. After reading the article, it looks like the only thing presently available to pilots flying non-inertial/doppler nav equipped aircraft is the buddy system: PIREPs. True, there's no current requirement to report shear, and no official doctrine on what to say or who to tell if you wanted to help your buddy coming down the slide behind you.

What would you want to hear from the guy 5 miles ahead who just had a hair-raising experience with shear? I want either the altitude he was passing or the approximate distance from the field or TACAN. Altitude is better for me because of two things: I have a good indicator in the cockpit, and I'll know where the shear is relative to the ground and will be able to judge the threat, i.e., is it going to get me while I'm still IMC, just as I break out and am trying to transition from instruments to visual, or in the flare?

So, fellow aviator, if you experience any of the weird sensations on final approach so well described and explained by Major Carpenter in the three part series, please remember that I might be coming down the slide behind you. Speak up and tell the controller to pass on to succeeding aircraft that (1) you think you encountered (moderate or severe) wind shear at (altitude MSL) which caused you to (sink or balloon), (2) you had (difficulty or no difficulty) coping with it, and (3) you corrected for it by adding some power, or adding full power or coming to idle for a few seconds. ICAO and the weather people may not have the terminology to communicate the true severity of the wind shear, but surely we pilots, who do so many things so much better in so many different ways can come to the rescue of the regulation and procedure writers and show them the way.

Voice from nowhere:

"You did your homework, Sonny. But don't let all that new knowledge and expanded perception cause you to expect too much from others. That guy down the chute in front of you may not speak up because he may not recognize a shear for any of several reasons. (1) It may be his first experience with shear—all prior lectures and articles may have gone clean over his head. (2) Regardless of his prior experience and book-learning, his present instrument proficiency and weak self-confidence may be such that he'll be kicking himself in the rear instead of analyzing what happened—so he'll fail to look beyond himself for reasons other than personal failure. (3) He may be one of the many pilots with a non-technical college degree who doesn't particularly like math or the 'quantified' or technical approach to flying topics. Hence he will have chosen not to read or study the *TAC Attack* series 'because they are too deep', and he may not recognize the shear or know what to say if he does recognize it.

"On the other hand, if that guy out in front has the drive to be the best pilot in his field, if he has strong survival instincts, or simply feels he's found another way of strengthening his wing or command's flying safety program and preserving its enviable flying safety record, then he will have done his homework and will have (1) gained a perspective on the occurrence of shear and effects of shear on the aircraft, its autopilot, and other automatic/sophisticated equipment and indicators, (2) chosen some visual or instrument clues pertinent to his type aircraft that will alert him to the occurrence of significant shear, and (3) will have planned in advance what he'll tell the Tower or Approach Control if he suspects that he encountered a significant shear."

For a first hand account with "instant shear", see the following article "Wind Shear Encounter On Takeoff." ★

Wind shear encounter on takeoff

During the late afternoon of 4 March 1976, while holding a DC-10 for takeoff on ORD Runway 14L, wind 130-140° at 5-8 knots, ceiling 100 feet RVR 1600 feet landing, 1000 feet rollout; two flights missed their approaches because they were unable to stabilize their airspeed. The tower later advised that there was a wind shear at 500 feet from 240° at 50 knots.

A Pilot Report:

"Just as we became number one for takeoff, two inbound trips pulled up at the middle marker due to severe turbulence. We were then cleared for takeoff. At 300 feet I began to increase my airspeed to 180 knots, 40 knots above V_2 expecting turbulence and wind shear. As we went through 500 feet on climb, our airspeed dropped instantly to 135 knots, a 45 knot decrease with heavy turbulence. The nose was lowered to level flight and it was quite some time before we regained V_2, and even more time before we could climb.

The point of this is that even though I was expecting a drop in airspeed I was shocked to see it drop so fast for so long. Had I been climbing at $V_2 + 10$ knots in this condition, lowering the nose to level flight would not have been sufficient to keep from stalling, and there was not enough altitude to swap for airspeed. I have flown through wind shear many times but I have never seen so great a change over such a short vertical distance. I am sure glad that I was expecting it."

The Weather Service was checked for a more detailed account of the weather picture at the time of the incident, and this description was obtained:

"The weather situation between 1800 and 1900 CST at ORD on 4 March 1976 indicates two types of low level wind shear. One type associated with a warm front and the other associated with thunderstorms to the northwest of the airport.

"A warm front extended from Burlington, Iowa, to just south of MDW. Surface winds in the cool air to the north of the front at ORD were south easterly at 5-8 knots, and the winds in the warm air aloft were from the southwest at 50-60 knots. The temperature difference across the front at the surface was approximately 20°. The normal slope for a warm front would have placed the wind shift line at about 400-500 feet about the surface in the ORD area with sharp wind shear.

"A northeast-southwest line of thunderstorms was located about 30 miles to the northwest of the airport. A gust front with the thunderstorms was indicated by the surface wind when they passed over O'Hare Field. The nose of this gust front aloft could have protruded ahead of the surface position by as much as two or three miles."

—Courtesy *The Grapevine.* ★

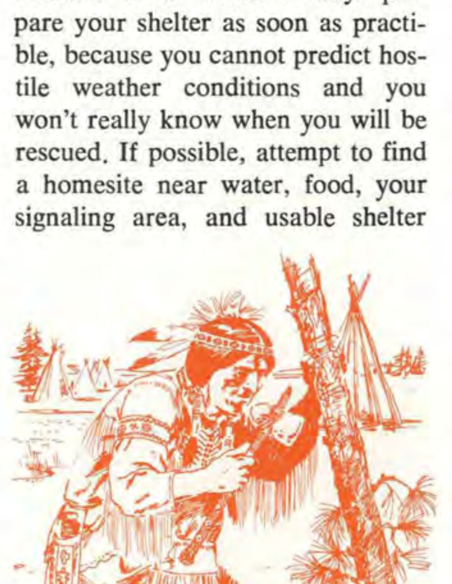
Take Cover, Men!!!

SGT HERBERT A. KUEKER
Programs and Current Operations Branch
3636th Combat Crew Training Wing
Fairchild AFB WA

Ever since man carried stone axes, there have been people on this globe who spent their entire lives wandering around in search of food. They have lived in a variety of housing, from caves to animal hide tents. Being transients, these people are never bothered, or concerned for that matter, with constructing a nice home equipped with swimming pool, rose garden or sauna. After all, not even Hollywood types would build a beautiful castle and then only sleep there one night. But, just as the need for temporary shelter is evident to "primitive" peoples, so should it be of concern to a downed aircrew member. Let us talk briefly about the need for temporary shelter, what it should consist of, and how to go about making or finding it.

Even though primitive man does not build mansions, he always keeps some basic principles in mind when looking for shelter: It should be near food and water, be easy to build, provide protection from the elements, and still be comfortable for all of the functions that will take place there.

If your bird ever lets you down and you're going to be on the ground overnight, you should remember those basics. Always prepare your shelter as soon as practible, because you cannot predict hostile weather conditions and you won't really know when you will be rescued. If possible, attempt to find a homesite near water, food, your signaling area, and usable shelter



construction materials. Now that does not necessarily mean that you should build a nine pole teepee next to a stream that runs through an open meadow. Why? Because there may be a cave or some other typ of natural shelter only 100 yard away. Anyone who has ever built a teepee out of parachute materials and poles can testify that it is a whole lot easier to move into a cave! At any rate, you *need* some type of shelter. Even on a mild summer night, the dew can soak you to the bone. Just imagine what a snowstorm or driving rain can do for your health and morale!

Well, if not a nine pole teepee, what *do* you need? First, you need something large enough for you and your equipment, something that will keep you dry, out of the wind, and allow you to rest. Everything you construct in addition to that is a luxury, such as using bark for a waterproof shingle effect on your roof, building a fireplace out in front of your shelter, bough beds, etc.

Any materials or location which can provide protection for you and your equipment should be used. For example, you can find shelter und rock overhangs, under heavy brush or tree limbs, inside natural caves, or maybe even in a culvert which runs underneath a road. It may seem tough, but the truly ingenious survivor will incorporate parts of a wrecked aircraft, his parachute, a space blanket, and some tree branches or anything else into a waterproof abode. The trick is maximum utilization of your environment. Just because it is out of the ordinary does not mean you cannot use it.

If you should have to move, always keep your eyes open for usable shelter areas. Immediate encampment may become necessary for a variety of reasons, such as the onset of nightfall, fatigue, weather, etc.

So, what have we said? Basically, that when you are a survivor, you, like primitive man, are transient, which means that you do not need a permanent home. Also, that no matter where you are, you *do* need some sort of shelter to protect you from the elements and bolster your morale, if you have to remain overnight. Obviously, your shelter has to be large enough to accommodate you and your equipment. And, finally, that you should use any natural formations or existing materials for the construction of your temporary home.

Keep in mind that primitive people have seen a need for shelter each and every night for millions of years, and they "still have not been rescued." So, as a survivor, you have to adapt to their ways and find shelter, whether it is for 6 hours or 6 days. The object of the whole thing is not just to look cool when the "white hats" come galloping over the ridge. You might make it without shelter, but you will be far better off warm and dry than cold, wet and miserable.

Questions or comments concerning the information contained in this article should be directed to 3636 CCTW/DOO, Fairchild AFB WA 99011, AUTOVON 352-5470. ★

When possible, survivor should try to locate shelter near water and food source. Cave, as in photo below, could make ideal shelter. Poles and parachute material can make a good teepee. Or, other natural materials can replace parachute cloth as in bottom photo.

THE IFC APPROACH

By the USAF Instrument Flight Center
Randolph AFB, Texas 78148

REVISED AFM 51-37, INSTRUMENT FLYING

The revised AFM 51-37 is now in distribution. If you've had a chance to look at the manual, you probably noticed that it has been completely revamped from cover to cover. While it is not within the scope of this article to cover all the changes, some of the more significant areas should be addressed in the hope that it will stimulate you to look closer at what we believe to be a manual vastly improved over the previous edition.

The first thing apparent to anyone familiar with the present manual is the complete change in format. The new manual has only seven chapters, as compared to eighteen in the old edition. This reduction was accomplished primarily by reorganization and the removal of outdated and unnecessary subject matter, such as radio range and the history of instrument flight.

The revised edition begins with general information about aircraft equipment and instrument flying in the first two chapters. The remaining chapters are organized sequentially from preflight through final landing, with the last chapter being devoted to supplemental information. A quick glance at the chapter titles below will more graphically illustrate the new format of the manual.

Chapter 1	Aircraft Equipment
Chapter 2	Basic Instrument Flying
Chapter 3	Preflight
Chapter 4	Departure
Chapter 5	Enroute
Chapter 6	Arrival
Chapter 7	Additional Information

For standardization and ease of reference, each paragraph has been numbered similar to Air Force regulations such as 60-16.

Along with the overall streamlining of the manual, a number of procedural changes have been made. Some of the significant changes are listed below:

1. The maximum teardrop angle for holding pattern entry has been increased from 30° to 45°. The resulting greater displacement from the holding course will allow fast movers, that have a large turn radius, a better likelihood of an inbound course interception without overshooting. The teardrop entry zone depicted on the upper right corner of high altitude approach procedures will continue to reflect 30° offsets. Pilots desiring to use 45° should consider other means of determining when they are conveniently aligned.

2. When performing a circling approach, either a left or right base turn is permissible unless restricted by the controller, the instrument approach procedure, or the Enroute IFR Supplement.

3. The tolerance for determining "on course" during descent has been changed. A pilot may now begin descent when within, and will remain within, $2\frac{1}{2}°$ of the desired course.

4. Pilots may now begin descent from a low altitude Initial Approach Fix (IAF) when abeam or past the IAF and on a parallel or intercept heading to the published course or arc. This new procedure standardizes descents from both high and low altitude IAFs.

5. Outbound timing for holding patterns, procedure turns, and holding patterns (in lieu of procedure turns) has been standardized. In all cases, timing is begun when abeam or over the fix, outbound. If this position cannot be determined, such as with some ADF equipment, then begin timing when wings level, outbound.

6. Pilot and controller responsibilities for obstacle clearance have been expanded. The manual contains a discussion of minimum vectoring altitudes used by radar controllers, and pilot responsibility for maintaining position orientation while being radar vectored.

7. Additional guidance has been added to ILS glide slope deviations. If you exceed half scale below glide slope or full scale above glide slope, do not descend below localizer only minimums. However, if the aircraft can be repositioned within these tolerances, you may continue the approach to published ILS minimums.

AMF 51-37 is no longer a required publication for all pilots. Commanders are authorized to determine their unit's requirements. However, sufficient copies should be maintained in each unit to ensure availability to all aircrew members.

Although smaller in overall size, many topics have been expanded and clarified to reduce confusion that has existed in the past. Additionally, wherever regulations and protected airspace allow, we have tried to give the pilot more latitude in his operations. Examples of this can be found in the areas of circling approaches and descent procedures associated with low altitude IAFs.

We feel that the new AFM 51-37 is a vast improvement over the last edition, but only constant updating will maintain its quality. If you have any questions or comments on how to improve or clarify AFM 51-37, call us at AUTOVON 487-4276/4884. We're waiting to hear from you. ➤

THUNDERSTORM AVOIDANCE IN TERMINAL AREAS

The preliminary findings of a special project group convened by the National Transportation Safety Board (NTSB) to determine the reasons for the increase in thunderstorm and wind shear related accidents have been made public.

NTSB figures indicate that between 1964 and 1967 there was one terminal area thunderstorm air carrier accident; in 1968-1971 there was also one accident. But during the years 1972-1975 there were eight accidents and 251 fatalities.

The group's preliminary findings included comments in the area of airline management, thunderstorm forecasting and dissemination, pilot training, pilot human factors and wind shear determination.

The study indicated that although airline managements have created an atmosphere of safety by supporting pilots' decisions and not exerting pressure on the pilot to "get it on the ground" regardless of terminal conditions, they have not positively told the pilot to "wait it out" in cases of terminal thunderstorm activity. The group found that policy statements concerning thunderstorm avoidance in the terminal area are insufficient in the majority of the air carriers questioned. An NTSB official commented that air carriers need to make a strong statement regarding go-around when unstable flight conditions are encountered below 400 feet. The group also found that training material concerning en route thunderstorm avoidance was excellent but information relative to terminal area thunderstorm activity was sketchy.

It was observed that the factors that motivate pilots to continue flight into a thunderstorm are self induced. The group found that peer pressure was non-existent and that competitiveness did not appear to be a factor in the pilots' decisions.

The study indicated that pilots' estimation of the situation and judgment, rely upon other pilot reports and information furnished by the controller. The pilot needs current information about wind, pressure changes, temperature and storm proximity, movement and intensity.—Courtesy NTSB Special Project Group Preliminary Findings ★

Hawaii Air National Guard F-102A and F-4C fighter interceptors. The delta winged F-102, commonly known as the "Deuce," was retired last October and replaced by the F-4C Phantom. Hawaii's Dueces were the last to fly as interceptors, although some will serve as drone targets.

It's Your Decision

If you fly an aircraft equipped with ejection seats there is little doubt that you can quickly and accurately quote all the words and figures from the Dash One about ejection procedures and altitudes. You know about that warning that says "do not delay ejection below 2000 feet in futile attempts to start engines" and the part that warns ". . . there is a progressive decrease in successful ejections below 2000 feet." You have also reviewed your personal ejection parameters. But, in this review, what do you consider? All too often we only think of altitude and airspeed in reaching our ejection decision because these are the most commonly quoted.

But zero/zero isn't the whole story. To really make an intelligent decision about when to eject we need to evaluate altitude and airspeed, yes, but also attitude, bank angle, and sink rate play an important part. It is the consideration of all these parameters that is most important in a low altitude ejection situation.

Let's take a hypothetical case. Shorty after the gear comes up on takeoff, you feel a couple of thumps. When you glance at the

MAJOR JOHN E. RICHARDSON
Directorate of Aerospace Safety

engine instruments, you see both engines unwinding (or **the** engine for you single-engine jocks). In either case, you are now riding in a less than perfect glider —so, what do you do?

You first go through the Dash One bold print emergency procedures. If you are lucky, the engine(s) start and you recover with little difficulty, and a good war story. But suppose they don't start? The alternatives are crash landing or ejection.

In most cases, ejection is preferable to a crash landing. The ejection seats in most modern aircraft have the capability to provide safe egress in almost any situation. The problem is that these seats are so good that we, the aircrews, sometimes press our capabilities too far. We ask for more than the seat can deliver.

Although the important part of ejection is in the bold print procedures, to get the most out of our equipment we need to understand a little about ballistics and vector analysis. The best way is to take our hypothetical case and look at the parameters we mentioned earlier and how they can affect your ejection decision.

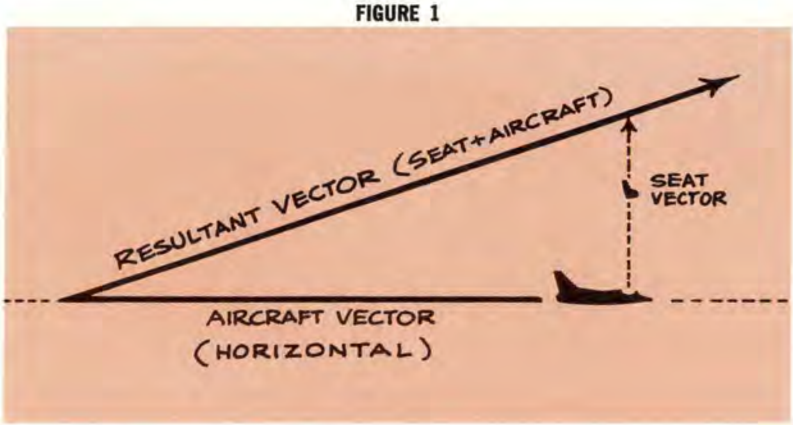
You may have considered the possibility of a flameout on takeoff and decided that just as soon as that engine starts to unwind you're getting out. Well, that is a decision no one with any knowledge of jet aircraft could fault. But if you merely let go and grab for the handles, you may not be giving yourself the best chance. Although you are almost certainly within the ejection envelope when the flameout occurs, you may be close to the edge. Most modern seats have at least a zero feet and 120 knot capability. But in this case we have more than 120 KIAS, and a few feet above zero. Obviously, this is better, but it can be improved further by trading airspeed for up vector. Notice I didn't say altitude. While altitude can give a cushion, the idea of zooming for altitude has an inherent trap we'll discuss later.

Now let's get back to why it's worth taking those few extra seconds to establish an up vector. First, that zero and 120 seat capability means that if everything works perfectly you'll make it. That's a big if. Any delay at all in seat separation, chute deployment or whatever and your chances nosedive. So let's increase the odds in our favor by using knowledge of vectors. A vector is the path traveled by an object having both speed and direction. In an ejection there are two main components which make up the vector of the seat once it leaves the aircraft. These are the seat vector and the aircraft vector. Figure 1 demonstrates this graphically.

It doesn't take a PhD in physics to see that if we change either component the resultant vector changes. Under controlled ejection above 2000 feet AGL there isn't much problem since there is ample time for chute deployment. But down at low altitude, things happen quickly. The secret to successful chute deployment is time. And, since the human body falls at a finite terminal velocity of 200 feet/sec, we can increase the time till ground impact by increasing the resultant vector of the seat after ejection.

To increase the resultant vector all we need to do is increase one component (holding the other constant). Since it is not possible for the pilot to change the boost of the seat, we must work with the aircraft vector. The two components of the vector are direction and speed. If we increase speed, we have more velocity at seat separation. The trouble is, with no thrust from the engines, the only way to increase speed is to dive. At low altitude this is not the wisest course. The other component, direction, is just what we are looking for. A slight change in direction can make a significant change in the resultant.

FIGURE 1



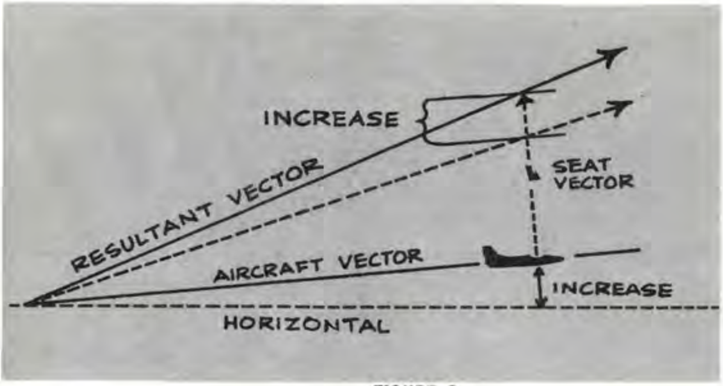


FIGURE 2

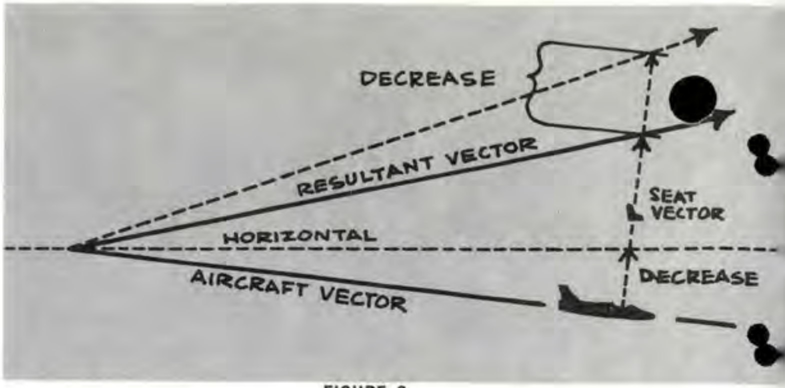


FIGURE 3

This is all very nice and if you can do it, the climb will help give you a cushion for safe ejection. But, just as a climb can help, a descent hurts in an ejection situation. Looking at Figure 2, if we change that slight climb to a descent, there is a dramatic decrease in the final seat vector.

Adding to the problem is the fact that the seat trajectory is the same in relation to the aircraft regardless of altitude, attitude or angle of bank.

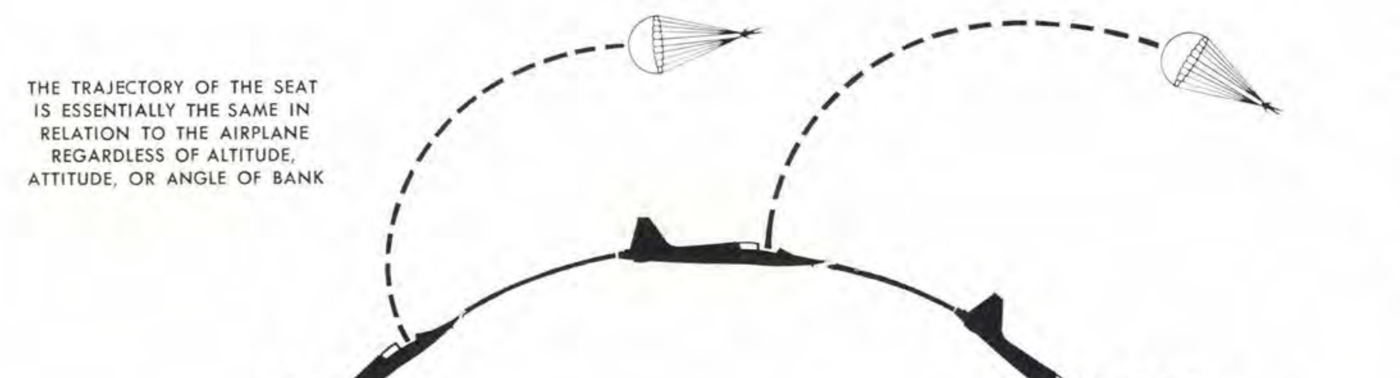
To give these facts some reality let's look at the capability of the F-4 seat as a typical example. Figure 3-5 in the F-4 Dash One shows a graph of minimum altitude required vs aircraft sink rate. For a sink rate of 1000 feet/min and 5 seconds reaction time for the pilot, the minimum ejection altitude is 100 feet. No sweat, right? Look at the other criteria: Aircraft speed 135-160 knots in LEVEL FLIGHT ATTITUDE. If we add a 15 degree dive even allowing only 2 seconds crew reaction time, the minimum altitude jumps up toward 500 feet.

The other factor which hurts us in an ejection situation is bank angle. This isn't as bad immediately as dive is. For example, Northrop states that, for the T-38 seat, a 30 degree bank only reduces the ejection seat travel peak by 14%*. Once past 30 degrees, however, things get worse rapidly. Figure 4 shows the effect of up to 90 degrees of bank.

*Talon Service News, Dec. 1967

By now we can assume you're convinced not to eject in a dive or sink rate (if possible). But you aren't home free just because you point the nose up and climb for altitude. Remember a vector has two components—direction and **speed**. Obviously, speed hurts going down but it can also hurt, or the lack of it, going up. If, when the fire goes out, you pull back and climb for maximum altitude before ejecting, you are also bleeding airspeed rapidly. Anything released with an initial upward vector must reach zero vertical velocity before it starts to fall. The distance you travel is directly dependent on your

FIGURE 4



acceleration times the time of acceleration and initial velocity. While modern ejection seats consider gravity effect in their boost parameters, once a sink rate develops this must be subtracted from the seat vector.

While it is true that you are better off with more altitude and, in most cases, optimum ejection (low altitude) is the maximum altitude you can attain, this point is a tricky one. If you delay too long you are past this optimum and into a sink rate and a much worse situation than if you had ejected slightly prior to maximum altitude.

Another concern is that the time required to get a full chute varies with airspeed. For the F-4 this time can be anywhere from 3.5 seconds at high speed to 6.5 seconds at zero airspeed. It would seem, therefore, that the difference of 100 feet or so may not be worth the loss of airspeed necessary to get it. For an F-4 let's assume an ejection at zero airspeed. The seat can give an average boost of 120'/sec. So, dividing by 32'/second for gravity, the result is a time-to-zero velocity of 3.75 seconds. This also will give an apogee of 305'.

From 305 feet, the body of the pilot will begin to free fall, accelerating at 32 ft/sec/second until terminal velocity of 200'/second. For the purpose of our discussion there remains 2.75 seconds until full chute. In this time the pilot will fall about 64 feet. This means full chute at about 240'. No problem if you are level and reach full height. But as we mentioned earlier, any bank or dive reduces the apogee —in a dive you can actually get a chute at a lower altitude than at ejection.

Now that we have all these nice facts and figures, what does it mean for our pilot? Obviously, right after takeoff he doesn't have a lot of extra airspeed or altitude. But he does have enough to establish an up vector and improve his situation. The choice of immediate ejection was discussed earlier. The one thing to avoid is delaying the ejection until airspeed bleeds off and a sink rate develops. Once that happens there is no slack left. Everything must work perfectly if you are to have any chance of survival.

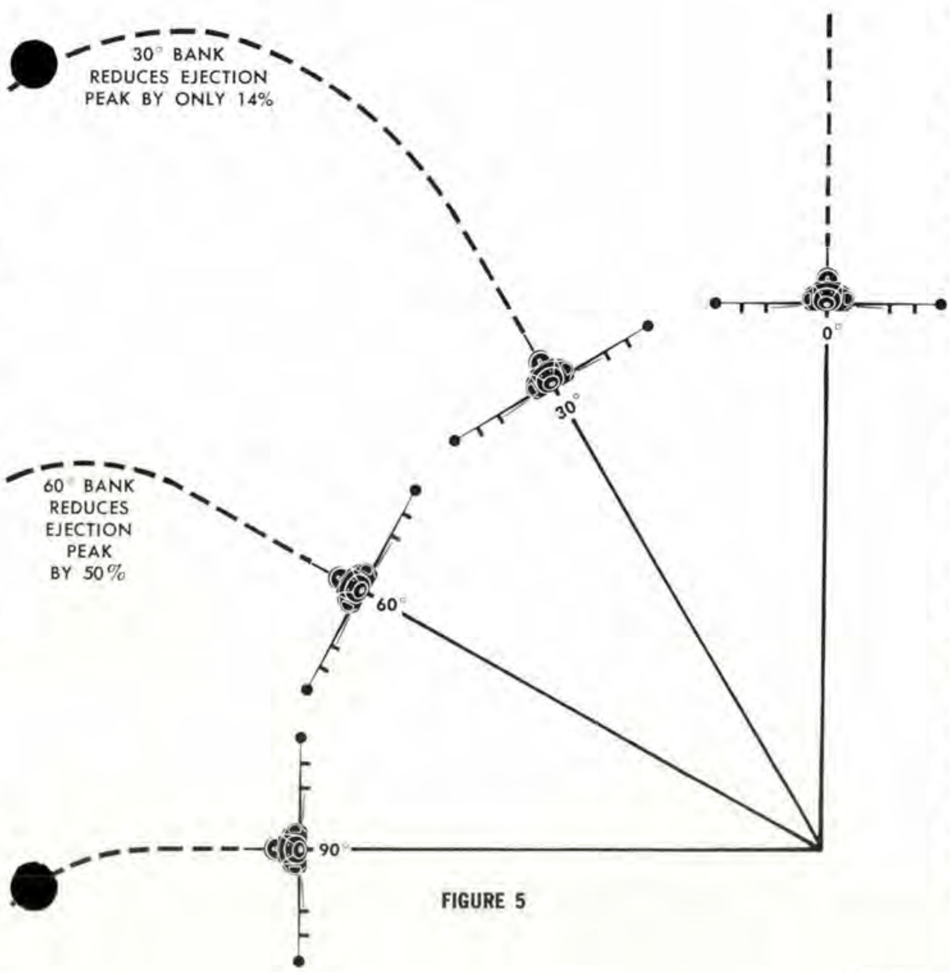


FIGURE 5

One other point. Low altitude doesn't necessarily mean 100 feet AGL. You should consider yourself in a low altitude ejection situation anytime you are below the altitudes for controlled or uncontrolled ejection listed in your Dash One. In a low altitude ejection situation, the most important factor is time. You need every second to give yourself the best possible chance.

The choices are yours. We are not trying to give you a panacea. Even in our hypothetical flameout there is no one correct answer. The entire situation has to be considered. The point of this whole discussion is this: Although Air Force aircraft are equipped with excellent escape systems, out-of-the-envelope ejections are still the leading cause for unsuccessful ejection fatalities. The decision is yours. You, the pilot, are the only one who can make it. Think about your decision before it's too late. ★



A DIFFERENT SIMULATOR

SGT. ROBERT M. CONNELL, JR.
48 AMS, Luke AFB AZ

Sim 18, a multi-million dollar weapons system training set, is a unique mission simulator in the United States Air Force inventory. In the beginning, Number 18 was a standard F-4E mission simulator exactly like the others stationed in various areas throughout the world. During shipment in Europe, an accident involving the tractor trailer rig in which part of the simulator was being transported resulted in fire damaging the equipment extensively. The US Air Force decided that, instead of junking a 1.7 million dollar machine, it could be refurbished with some up-to-date adaptations and return to the inventory as a research and development tool.

The refurbishing was accomplished by a contract awarded to Singer's Simulation Products Division and included the following additions to the basic weapons systems training set: 1. A visual system incorporating a model board for air-to-ground work. 2. A 48" stroke, 6 degree freedom of motion system. 3. Pneumatically operated G seat/G suit system. Later a digital radar landmass simulator (DRLMS) was added.

Sometime during the refurbishing, Number 18 came to be known as "Old Smokey" by those associated with the project. If one were to come to the Advanced Training Devices Branch at Luke AFB, he would see pictures of Smokey the Bear in a few places even today. It's almost like a mascot without the mess!

"Old Smokey" arrived at Luke in February 1975 minus the DRLMS. The simulator was assembled by Singer who had also been awarded the maintenance contract. Acceptance test procedures were completed by the Air Force in July 1975. With the addition of a Halon fire suppression system in January 1976 and DRLMS in April 1976, we have the completed mission simulator as it stands today.

As we enter the enclosed simulator area, the first area of interest is the operator's console. Here the console operator controls various effects on the mission ranging from environmental to radar jamming. A range of malfunctions may be used in training emergency procedures while the instructor may sit down at the console and monitor the pilot's and WSO's actions through repeater instruments and systems status indicators.

For monitoring of landmass runs, the console also contains a radarscope and associated controls with indicators for all weapons' status and modes. All communications and navigation capabilities are also simulated. G seat, G suit, motion and visual systems controls incorporated into the standard F-4E simulator operator's consoles allow operator manipulation of these systems. Air targets, capable of jamming, may also be inserted; however, they do not produce a visual image. The air targets do show up on radar and when the parameters are correct, may be shot down with any of the usual air-to-air weapons which are loaded on the "aircraft" from the operator's console. One would conclude, therefore, that F-4E Number 18's air-to-air capability would be limited to basic air combat maneuvers.

Air-to-ground capabilities are much broader as an 11 x 4 mile area of terrain is simulated with a model board which provides visual targets for a pilot to bomb. By selecting one of the model board targets from the facility control panel on the operator's console and then inserting it as the target to be bombed, a crew may practice dive bombing this target. After impact of the bombs, which does not show on visual, a "score" is automatically printed on the Situation Display indicator (SDI) telling release parameters, distance from and clock position from the target where the bombs fell. This feature assists in training, as on the next run the pilot can know the results of his last run and adjust the pipper/target relationship for a better score.

Another interesting console function is Tactics Test Number 45. Initiating this again incorporates the SDI, except now vectors are displayed showing glideslope and centerline from which an operator

A DIFFERENT SIMULATOR
continued

can talk a pilot down by Ground Control Approach (GCA). This feature is common to all F-4E sims; however, when you as an operator take the visibility down to 500' and lower the cloud base to 200' AGL on the visual display which the pilot observes, things become a lot more interesting. No pilot wants to miss the runway, even in the simulator!

Upon entering the high bay area, one immediately notices the incredible size of the motion base with its six legs looking somewhat like an injured insect. On top of the motion platform are the cockpit and visual head assemblies where the actual benefit of simulation takes place. Located directly behind the motion platform is a service platform with a stairway for access to the motion platform. Underneath the motion platform is a maze of hydraulic, water, air, and electrical lines which drive the motion platform and basically, make the system work.

The water lines cause concern at first because water lines running in the middle of all that electrical equipment doesn't seem quite right, but it's said that the distilled water that runs through them has extremely low conductivity to electricity. The water is necessary to cool the 12 deflection amplifiers contained in the visual head as they use large amounts of current to display the visual images on the six cathode ray tubes (CRTs), also contained in the visual head assembly.

The high visibility yellow platform in front of the motion platform is a maintenance aid for getting to the components in the visual head. Also down on the floor is a water softener for the four air conditioners which cool the simulator's enclosure. Along the walls, the various sized spheres are containers of Halon gas which is a colorless, odorless, tasteless gas used for fire suppression. The fittings connected to the spheres are for distribution of the Halon gas. In the event of fire, sensors strategically placed throughout the simulator would detect the ionization and smoke from the fire, alert the master control box, and, if the condition warrants, "dump" the Halon gas. At this time the fire would immediately be defeated and the gas would dissipate leaving no fire and no residue. All things taken into account, the Halon fire suppression system is pretty nifty. The gas doesn't even affect humans as long as exposure time is kept to a minimum.

Ascending the stairs of the service platform and passing through the gate at the rear of the motion base brings us to the cockpit assembly. The pilot's canopy has an extra hinge facilitating easier access to the front seat as the visual head would be in the way otherwise. The switches and indicators in both front and rear seats are set up like the cockpit of an F-4E and all systems are simulated, hence, a mission simulator. Also a part of the front seat itself are 31 individually controlled air bladders which, inflated and deflated by the computer, provide certain sensations such as sustained acceleration and bank. These physical cues are necessary to back up the cues from the visual display and the initial cues produced by the motion base.

To provide for sustained positive and negative G cues, a G suit is operated pneumatically by the computer. G suit pressure per G and pilot weight for the G seat are controllable from the operator's console. Contained within the visual head, the six CRTs mentioned earlier actually face straight down. Beam splitters and mirrors bend and shape the combined display of the tubes so that the pilot's head becomes the focal point of the display, which is 120 degrees in the horizontal and 60 degrees in the vertical. The pilot's seat can be adjusted; no visual cues are provided for the WSO.

Once the crew is strapped into the cockpit and certain other interlocks are made, the device is ready for operation. When the "motion on" button is depressed, the service platform lowers to ground level and the motion base erects to half the complete extension of the

six legs, or about 2 feet. This is the neutral position and from here the motion base is free to move in six different degrees: pitch, roll, yaw, straight up or down, longitudinally and laterally. If you like to do spin recoveries, we have motion sickness bags on hand!

Next stop is the model room. The three main features of the model room are the model board, gantry assembly, and the light bank. The model board covers an 11x4 mile area of simulated tactical targets such as factories, train yards a city, rural areas and natural looking terrain, including conventional and nuclear bombing ranges. Luke's runways are also on the board; however, they are not staggered as in the real world due to lack of space. TACAN and INS are aligned to the end of the runways making it possible to practice TACAN approaches and touch and goes.

Mirrors surround the model board to give it an endless look when viewed through the camera, so a pilot doesn't get the impression of flying off the end of the world when flying off the board. Cotton placed on these mirrors simulates clouds which look very realistic when viewed through the camera. As you fly off the model board, synthetic terrain generation (STG) provides a display of mile-square areas of different colors that vary in apparent size, depending on your altitude. A gray horizon and blue sky are also generated. This combined display provides a good ground reference for VFR maneuvering.

The gantry assembly holds the camera with a fisheye lens to simulate flying around within the model board area. The fisheye lens is servo controlled to roll, pitch, or yaw corresponding to aircraft movements. The extension from the gantry on which the camera and lens is mounted moves in and out from the model board to simulate altitude changes. The gantry's up and down, left or right movements provide simulation of aircraft movements within the board's area. The gantry assembly is capable of moving a maximum of 6 inches per second which translates to 550 knots as viewed from the cockpit. The light bank consists of 88 one thousand watt mercury lamps. With fill in lighting on the gantry, shadowing is kept to a minimum for daytime simulation. Twilight simulation is achieved by lighting every other lamp, and night flight is simulated by turning all lamps off. The model board is illuminated for nighttime simulation by fiber optics inserted from the back of the model board. By matching the color of the light sources with points to be illuminated, taxiways, threshold, and other pertinent night lighting may be accurately simulated.

Moving right along to the computer room brings us to the source of all of the systems' "brains." One GP-4B drum type computer is responsible for making the simulator fly and controlling all functions except production of the landmass picture. The other cabinets in the room, with the exception of the DRLMS cabinets, are power supplies and linkage between the GP-4B and other simulator systems.

The digital radar landmass simulator has its own computers which are two Raytheon 704 digital processors. Instead of having a landmass plate as the analog landmass does, DRLMS stores all the information for a 1250 mile square on a disc as magnetic spots. The processors take this information and through a very elaborate process produce a landmass return for the radar scopes, just as if we were flying over the terrain in an actual F-4E aircraft. As a matter of fact, our simulated picture is too good, as compared to the airplane, so we had to add noise to garbage it up a bit. If a certain terrain feature doesn't look like it ought to, we have several means at our disposal to change it to what it should look like. By simply changing the disc we can produce a simulated radar picture of any place in about five minutes. The analog landmass simulator required about two hours of plate replacement and alignment to do the same thing. ★

OPS TOPICS

SAME SONG DIFFERENT VERSE

A few years ago a T-38 was involved in a minor accident after a no flap emergency landing. The entire sequence was set up when the ignition circuit breaker panel was installed backwards. This caused the wiring bundle to rub on the throttle cables. As a result the bundle shorted and caused a complete electrical failure. Well, recently, the sequence started again (almost) when an ignition circuit breaker panel was installed backwards. Fortunately this time all that happened was a stuck throttle. The question is—what happened to the pilot's interior preflight?

KIND OF WINDY

It has happened again. An Aero Club Cessna 150, taxiing to the runup area prior to takeoff, passed behind a C-130 that was making a ground maintenance run. The prop blast from the C-130 tipped the Cessna up on its nose gear and right wing tip. The Cessna was 229 feet from the tail of the C-130. If you must taxi behind another aircraft in runup position, be sure he is not up to power. Call ground control and ask the other aircraft to maintain idle until you are clear.

FAA ADOPTS NEW TRAFFIC MANAGEMENT SYSTEM

The Federal Aviation Administration has adopted a new, comprehensive air traffic management program designed to enhance safety and efficiency in air traffic handling, conserve fuel and reduce noise over airport communities. The FAA action was taken in response to EPA proposals for new aircraft noise-abatement operating procedures at airports. FAA said the best means of achieving the objectives of the EPA proposals is a comprehensive order directed at those who control air traffic rather than inflexible rules directed at pilots.

Called "Local Flow Traffic Management," the new FAA program is aimed at reducing low altitude flying time by jet aircraft in terminal areas. It incorporates such features as: Increased use of idle or near-idle thrust descents, metering aircraft into terminal areas consistent with airport acceptance rates, absorbing unavoidable delays at or above 10,000 feet, standardized arrival procedures and earlier climb-outs for departing aircraft.

GOOD SHOW

The FCF on an F-100 went uneventfully until flare for landing, when the aircraft started a rapid yaw to the left. The pilot felt that the left rudder pedal was moving without pressure and full right pedal pressure could not stop the movement. The pilot forced the nose gear to the ground, deployed the drag chute and used differential braking to stop. After the aircraft stopped, the pilot found the left rudder full forward and frozen in position. This pilot showed excellent presence of mind in a critical situation.

STOWAWAY

While enroute to an air refueling rendezvous, an A-7 pilot found a wasp in the cockpit. The wasp eventually lit between the right canopy rail and the canopy plexiglass. The pilot attempted to crush the wasp with his checklist. On the fourth or fifth attempt, the canopy plexiglass disintegrated. The aircraft made a safe recovery at home base. The pilot is not thought to have exerted excess pressure on the plexiglass, but the reason for the failure is undetermined.

OPS TOPICS

IF YOU PLAY WITH ICE YOU MIGHT GET BURNED

A pilot and his two passengers were returning from a local VFR flight. En route, the pilot encountered light rain but managed to remain VFR below the overcast. One of the passengers then noticed a thin film of ice forming on the wings. The pilot did not become too concerned at first until he realized that the ice formation was quickly spreading across the wing surface. To make matters worse, ice then began to form on the windshield—the pilot turned to the instruments, but they were reading erroneously! The pitot tube was covered with ice, and ice began accumulating astonishingly fast. Then the aircraft began to vibrate due to ice accumulation on the prop. The pilot found the controls to be sluggish, and it became difficult to maintain air speed and altitude. He tried to radio a distress call, but radio responded only with static—the antenna was covered with ice. The pilot and passengers panicked. Vertigo set in, and the aircraft entered uncontrolled flight. Impact occurred in an open field three miles from the airport. This entire incident happened in less than 20 minutes. The result: Two people sustained serious injuries, one minor.—Courtesy Aviation Monthly, Vol 4, No. 12, Dec. 76.

NEW FAA LOW-ALTITUDE WARNING FEATURE

The Federal Aviation Administration has added a new low-altitude warning feature to the automated radar terminal systems (ARTS III) at Washington's Dulles International Airport and Los Angeles International Airport.

Four additional ARTS III sites—Detroit, Denver, Houston, and St. Louis—are scheduled to receive the added safety feature by February 1977 and all 63 ARTS III sites by mid 1977.

The new safety feature, called Minimum Safe Altitude Warning (MSAW), automatically monitors aircraft altitudes and compares them to an altitude table programmed into the ARTS III computer. When the computer detects a potentially unsafe altitude condition with respect to terrain or obstructions, a five-second aural alarm sounds and the words "LOW ALT" appear on the controller's radar scope above the appropriate aircraft target.

Generally, MSAW monitoring begins when an aircraft enters the terminal area, which may extend outward as much as 55 miles from the airport, and is picked up by the ARTS III radar. MSAW alerts are provided to the controller automatically on instrument flight rule (IFR) aircraft and visual flight rule (VFR) aircraft when requested by the pilot. In either case, the aircraft must be equipped with the 4096-code transponder and an altitude encoder.

SLOW DOWN

An F-100D was taxiing back to the ramp on an inactive runway when a thunderstorm hit the field. With a wet surface, limited visibility, and a 20-30 knot tail wind, the pilot was taxiing with near "normal" speeds. Due to the limited visibility, the turn off to the taxiway came up a little fast. The pilot braked in the turn and entered a viscous hydroplaning condition. The aircraft yawed, departed the runway, and a main landing gear collapsed. The damage was sufficient to be categorized as a minor accident. "Normal" taxi speed can be much too fast for many conditions.—Major Lawrence E. Wagy, Directorate of Aerospace Safety. ★

mail call

Send your comments and questions to:
Editor, Aerospace Safety Magazine
AFISC/SEDA
Norton AFB, CA 92409

THE LANGUAGE BARRIER

Congratulations and well done to Major R. P. Bateman for his "What's A Cubit?" in the November '76 issue. His "assault on the language barrier," however, will probably not make much of a dent on USAF writers, most of which will no doubt continue their own assault on clear thinking and straight talk by continuing to use their own versions of the "cubit" whenever possible. As a close to home "F'rinstance," take one of the question and answer sets in the November "IFC Approach." A bewildered pilot asks what the term "fly-up" means in the ILS chapter of AFM 51-37. The IFC answer? "A fly-up indication tells you that you are below the glide path and that you must fly-up to get back on it." In other words, "fly-up" means "climb." To "fly-down", we assume, is to descend. As long as we insist that straight talk isn't good enough for us, simple assault on the language barrier isn't enough. We need to declare all-out war on people who are fond of calling a spade a "manually-operated earth redistribution device."

Incidentally, Air Weather Service has published a wallet-sized equivalent chill temperature chart similar to the one on page 21 of the November issue. It's officially referred to as AWSVA 105-12. It comes in living color, gives temperature in both old-fashioned Fahrenheit and today's Celsius and, best of all, it's free at your local base weather station.

You have a fine magazine. Please keep the good words coming.

GEORGE M. HORN, CMSgt, USAF
Weather Operations Superintendent
DCS/Operations
Air Weather Service
Scott AFB, IL

The terms "fly-up" and "fly-down" have been eliminated from the new AFM 51-37.—ed.

A LESSON FROM LARRY

I found the article in the November 1976 issue, entitled "Lesson from Larry" interesting and quite sobering for all aircrew members. Although I am not a rated officer, I have had the privilege of attending a briefing given by Brig. Gen. William Spruance (Ret.) of the Delaware Air National Guard on two occasions. I had heard him speak to the aircrew members of our unit about his experience in a T-33 crash and the effects of heat and fire on nomex clothing. He and a young pilot had taken off in the T-33 and were at an altitude of 200 feet just after take-off when they experienced flameout of the single engine aircraft.

After spending two years in a hospital as a result of burns sustained in the crash, General Spruance began an intense effort to speak to groups of aircrew members about the need to wear flight clothing properly.

I had a second occasion to hear General Spruance's presentation as an Officer Candidate at the Air National Guard Academy of Military Science in Alcoa, Tennessee in 1974. At that time, his briefing included color slides of his condition immediately upon entrance to the hospital and after two years of treatment. To anyone who saw these slides and heard his presentation, the impact of both was thorough and, I am sure, remained distinct in our minds.

As an addition to his presentation, the General provided much data compiled from other aircraft accidents that involved burns to aircrew members. He showed statistically and pictorially, that areas of skin not protected by nomex material were more severely burned, and that nomex gloves and suits —even ordinary clothing—will offer more protection against skin burns.

RAYMOND A. PATRONE, 1st Lt
143 Tactical Airlift Group
R.I. Air National Guard

NAME THAT PLANE

Can you name this aircraft? This early assault aircraft was a forerunner of the C-130 and was the first of its type designed with a wheel-ski combination. (For the answer see the inside front cover.)

* * *

CALCULATORS ON AIRCRAFT

ASD has tested and approved for use on board aircraft several models of calculators:

- Sharp EL 816
- Olivetti Divisuma 18
- Cannon Pocketronic
- Texas Instruments Datamath TI-2500, SR 50, SR 52
- Commodore mm3m
- Hewlett Packard HP 25, HP 45, HP 55, HP 65
- Nav Tech NC-2

These calculators were evaluated by ASD at the request of using organizations. ASD has certified them as not affecting safety of flight. However, there is a slight chance that in some high electromagnetic energy environments the calculators may give incorrect answers. If such an instance occurs, advise ASD/ENAMA and your MAJCOM safety office by priority message.

* * *

CORRECTION: The Ops Topic "How to Zap TA" in the December 1976 issue was incorrect. What actually happened was that, while the canopy was not jettisoned because it was open, all the canopy jettison explosive components functioned.

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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

Horace E. Johnson

CAPTAIN

Alan C. Murphy

STAFF SERGEANT

Marcelino Martinez

24th Composite Squadron

On 9 August 1976, Captain Johnson, Captain Murphy, and Staff Sergeant Martinez were engaged in the infiltration—exfiltration training of a combined USAF Combat Control and US Navy SEAL Team. Prior to flight, the trainees, who were to climb up to the aircraft on rope ladders and then rappel to the ground, were thoroughly briefed on emergency procedures by Sergeant Martinez. After takeoff, initial hover was established at 35 feet above the ground and the first three trainees were cleared to the ladders. As the first two trainees began to ascend the ladders, all tail rotor thrust was lost. The aircraft began a clockwise spin, with a slight nose "tuck." Captain Murphy quickly analyzed the critical situation, retarded the throttles to flight idle, and executed a hovering autorotation. During the descent, the aircraft continued to rotate through two full 360 degree turns. Through close crew coordination, the nose tuck was corrected by cyclic control inputs and by reference to the sweeping horizon. As these events occurred, the trainees trapped on the ladders and the trainee stabilizing the ladders were able to follow the pre-briefed emergency procedures and roll clear of the aircraft without injury. Just prior to touchdown, the collective pitch control was increased to minimize the rate of descent. At touchdown, the rotational inertia of the aircraft and grassy cover of the landing site allowed an additional 30 degrees of turn to occur. The mission planning, briefings, crew coordination, and the instantaneous correct actions of the flight crew and trainees resulted in recovery of the aircraft with minimal damage and no injury to personnel. The elapsed time from control failure to touchdown was less than 10 seconds. Subsequent investigation revealed a failure of the tail rotor drive quill shaft coupling which resulted in the complete loss of tail rotor thrust. The professional competence of the flight crew can be credited with saving a valuable aircraft and averting injury. WELL DONE. ★


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