AEROSPACE

SAFETY

UNITED STATES AIR FORCE

JULY 1965

Rough Rider '64

page two

AEROSPACE SAFETY

CONTENTS

Lieutenant General William K. Martin — The Inspector General, USAF
Major General Bertram C. Harrison — Deputy The Inspector General, USAF
Major General Jay T. Robbins — Director of Aerospace Safety
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AFRP 62-1 VOLUME 21 NUMBER 7

FALLOUT

HELP REX

Dear Tom

My associate, Rex Riley, is mighty unhappy these days; and when he is unhappy, he's most difficult to work with. When I brought him his usual cup of coffee and aspirin, he was staring at a map of USAF active major installations.

Twenty minutes later he had not touched the coffee and three aspirin. He held up the map. "Toots, LOOK at all of these 180 bases that we have in the U.S. and abroad . . . at least half of them should be on my list of outstanding bases!"

I told him he didn't have to yell, but he didn't hear me. He went on: "I know there are some good bases that I haven't looked at, and probably never will — you see, I can spread myself out just so thin."

I nibbled on his untouched aspirin and told him sympathetically that I thought it would certainly help matters if all of the pilots would give him a hand by evaluating the bases they visit, and write to him when a base is particularly good or bad. Imagine me telling Rex that that's the way he could get full coverage, and that the bases he would have to check (the particularly good or bad ones) would be limited to a reasonable number that he could evaluate properly.

I waited breathlessly as he reached for his coffee and one aspirin. I knew that he knew that, without my telling him, but my "woman's intuition" told me that he just wanted someone to agree with him. He declared, innocently, "Why, Toots, that would solve the problem; why don't you write your friends on AEROSPACE SAFETY magazine and ask them to query the pilots on this for me?"

So, there you have it, Tom. To get Rex off that aspirin kick, how about asking your pilots to give him a hand?

TOOTS

Rex really does need assistance. I used to help him with his program . . . before that awful phrase, "45-22," came along. That cleaned out a bunch of us not-so-terribly-old jocks. You'll have to agree that 180 bases are a lot for one man to visit. His program is operated exclusively for your benefit, you know. Write Lt Col Rex Riley, DTIG, USAF (AFIAS-E2), Norton AFB, Calif 92409.

Recommendation: That AEROSPACE SAFETY publish an article summarizing this accident and stressing the importance of personal equipment.

OUT OF THE HOT SEAT

Twenty-seven minutes after takeoff the F-89 was cruising at 31,000. Cloud tops were 5000 feet below. An Air Force base was 45 miles away. Suddenly, severe vibrations shook the aircraft. Quickly, the pilot scanned the cockpit. Two lights flashed on, indicating failure of Nr 1 and Nr 2 right hand generators. The pilot interpreted these lights to be an indication of trouble in the right engine. He reduced power to idle on the right engine and to 89 per cent on the left. He requested and received a vector to the Air Force base. While descending he attempted to reset the generators without success. He broke out of the clouds at 18,000 feet, 18 miles west of the base. Vibrations continued. Now the pilot noticed smoke in the cockpit. He stopcocked the right engine. Vibrations still continued. He spotted the field and lowered the gear, preparing for a single engine landing. When over the end of the runway at 14,000 feet severe explosions jarred the aircraft ("like running the nose wheel over a railroad track," was the way the pilot described it). They came from the left engine. He shut it down by using the fire selector switch and stopcocking and attempted to restart the right engine. The smoke was getting worse, no let up in vibrations.

Flames dictated the next course of action. The pilot noticed the flames on both sides of his seat. The left overheat warning light came on. He decided to eject. He used the fast jettison T-handle to jettison the canopy rather than the right arm rest. The canopy separated. Smoke and flames were increasing. The flames were blue, as if coming from blow torches. They were worse on the left side. The pilot was having difficulty locating the left jettison handle in the flames. His visor was not down and, although he doesn't remember removing it, there are indications that his oxygen mask was not on. (Investigators felt that the mask came off when he jettisoned the canopy.) Flames were spreading and his face, except for the area protected by the helmet and chin strap, was being burned. He had steered away from the field, toward a wooded area, and had managed to pull the left ejection handle. The board reasoned that, because he had used the T-handle rather than the arm rest, perhaps 10 to 12 seconds delay ensued between the time the canopy departed and he was able to eject himself. Ejection was fully automatic and without incident. The chute canopy caught in a tree top and the actual landing was quite gentle. The base had been alerted to the emergency, the Air Rescue helicopter was airborne and picked up the pilot one minute after he landed.

Injuries consisted of second degree burns of the face and right hand and third degree burns to the left hand. The medical officer observed that flames had apparently reached the top of the cockpit, permitting burning of the face in areas not covered by the helmet. He also observed that the tinted visor was not down, and that had it been down facial burns might have been reduced by one-third. Severity of burns to the pilot's hands resulted from the failure to wear gloves. The intense heat melted or burned much of the synthetic material in the legs of the winter flying suit. However, the flannel layer underneath remained intact and afforded the pilot protection. Leather boots, two pairs of socks and a flying jacket provided additional protection.

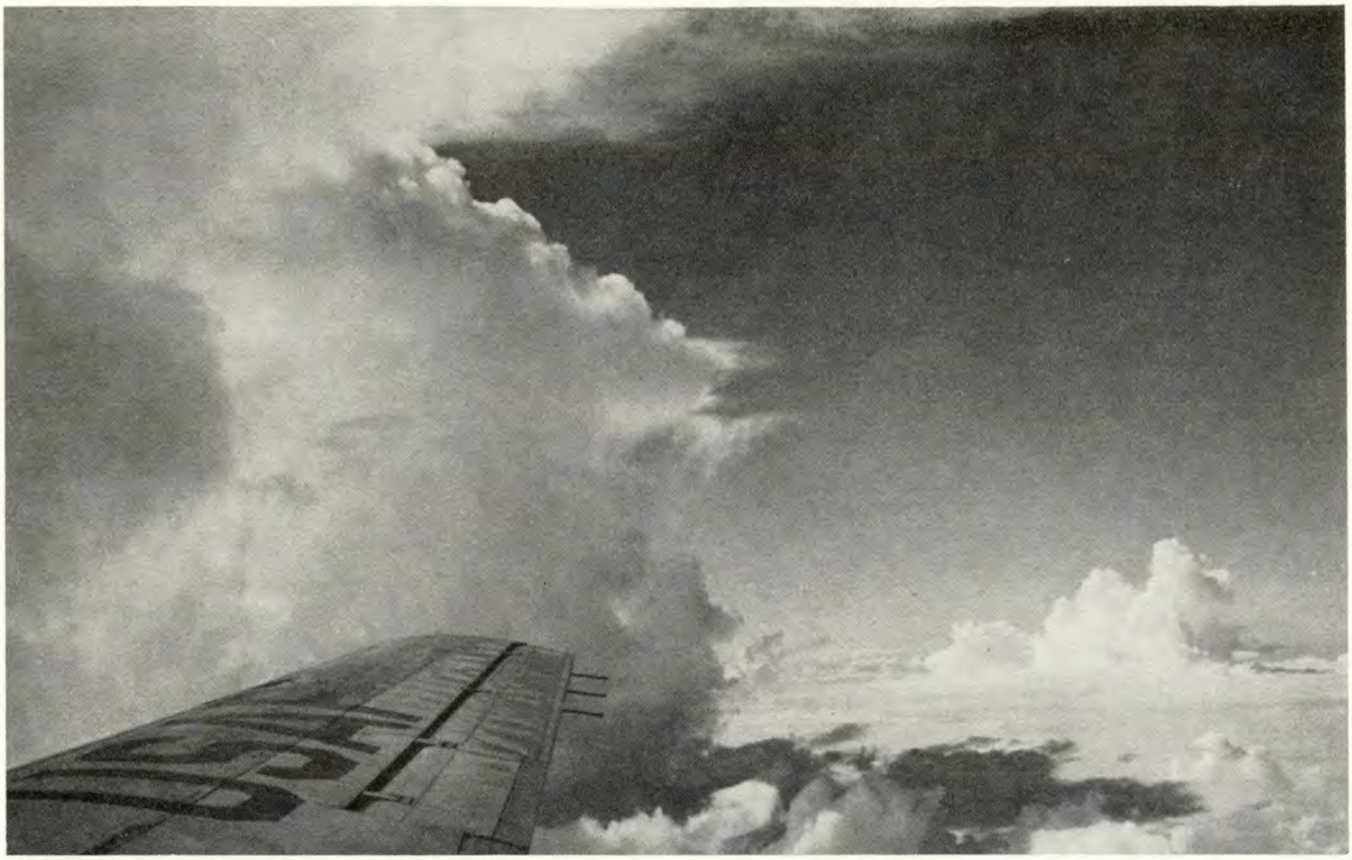
Reviewers concluded: This accident again illustrates protective measures afforded by use of visors, gloves and adequate clothing; the value of knowing the ejection routine; the importance of deciding and acting rapidly in an ejection situation; the role of prompt rescue action and medical care.

TDR's disclosed that the vibration stemmed from loss of a turbine blade in the left engine. Two possible explanations are given for failure of the two right hand generators, which led the pilot to erroneously believe his troubles were with the right engine:

1. Over-voltage of the left generator and failure of the over-voltage relay to disconnect the left generator from the primary bus. The reverse current relays on the two right hand generators would then disconnect them from the primary bus.

2. A short or open circuit in the control circuitry for the right hand generators. These circuits are located in the left engine intake duct and could have been affected by the vibration of the left engine.

While on single engine in the overcast between 26,000 and 18,000 feet the pilot was preoccupied with flying instruments, navigating for position and communicating with Center. In addition, he was faced with severe vibrations in the aircraft, smoke and subsequent fire. Under such circumstances, the failure of the pilot to identify indications of left engine malfunctions are considered reasonable. ★



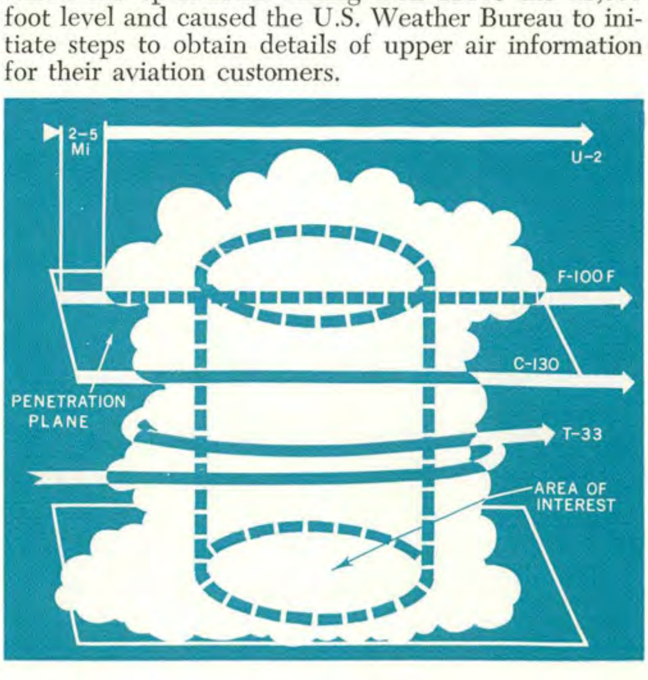
ROUGH RIDER 1964

By Major O. Patrick Arquilla, ASD, Wright-Patterson AFB, Ohio*

In flights through thunderstorms, the pilot and his airplane are too often the loser. This fact is evident if you examine the frequency of jet airplane accidents and incidents attributed to thunderstorms during the past few years. It is the purpose of this paper to present my experiences during flights through thunderstorms. Also, to present a general review of techniques and cautions that may be observed while penetrating thunderstorms in hope of clarifying some of the factors leading to defeat.

In 1946-47 a joint civilian and military effort participated in a test program called "Thunderstorm Project." As a result, there was a great advance in the technological understanding of the mechanism and composition of thunderstorms and the hazards encountered in flying through them. However, those studies were generally limited to the lower altitudes (below 26,000 feet). Since that initial effort, the type of aircraft and scope of operations of both commercial and military aviation have so expanded that new problems have arisen in connection with thunderstorm flying.

The advent of jet aircraft into commercial aviation raised the operational ceiling well above the 25,000 foot level and caused the U.S. Weather Bureau to initiate steps to obtain details of upper air information for their aviation customers.



*The author requests that note be made of the fact that the conclusions herein are his and not necessarily those of the Air Force.

Simultaneous with this effort, the U.S. Air Force also recognized the lack of information at high altitude in thunderstorms. Pressed by several accidents, the Air Force began formulating a plan to obtain data on the detection, avoidance and flight techniques required to fly in areas of thunderstorm activity. The formulation of this plan became the responsibility of the Aeronautical Systems Division (ASD) in the Air Force Systems Command.

The plan is called project "ROUGH RIDER." It is a joint effort with the U.S. Air Force, U.S. Weather Bureau, Federal Aviation Agency, and the National Aeronautics and Space Administration. Flight testing began in 1960 and has continued every year since. Of particular note, I direct your attention to the successful completion of five years of flight tests, and the accumulation of severe storm data during 564 storm penetrations, through an altitude envelope of 15,000 to 45,000 feet and a speed envelope of 175 knots to 1.72 mach *without* a single loss of aircraft. This impressive record and the experience gained by ASD test pilots is the basis of most of what I have yet to say. First, however, I'll outline last year's project.

TEST PROCEDURE — ROUGH RIDER 64

Test data gathering flights were flown simultaneously by a C-130, a U-2 and the penetration aircraft – an F-100F (Figure 1). The U-2 flew at high levels over the top of the cloud; while at the same time, below and about two to five miles behind, the F-100F penetrated the cloud while the C-130 flew outside the cloud approximately parallel and at the same level of the F-100F. This flight pattern was used for recording simultaneous electric field measurements of selected storm complexes.

A B-47, from ASD, participated by dropping chaff above the storms. Chaff drops were made only *after* storm penetrations were completed. Many times the altitude of the storm top was higher than the service ceiling of the B-47. For such cases, chaff drops were made around the thunderstorm complex. The experimental chaff drops were very successful in discerning differential movement between the outer edges of the cloud systems and the storm center. Wind flow patterns near the top of storms were also studied.

The only other test aircraft involved in Rough Rider 64 was a U.S. Weather Bureau F-11. This aircraft was under the sole operational control of the U.S. Weather Bureau. Its primary function was to climb outside the storm at a rate-of-climb equal to the rate-of-vertical lifting of the storm top.

Finally, we had a T-33 safety chase aircraft that orbited outside the storm area while the F-100F penetrated. The value of having a safety chase aircraft has been proven on several occasions during Rough Rider 64 (for which I was very thankful) and also for previous years.

I flew a total of 128 thunderstorm penetrations during Rough Rider 64. Much of what I experienced is applicable to all high performance jet aircraft. Enough for the background of Project Rough Rider. Now I'll move on to thunderstorm experiences – mine and those of other test pilots in ASD.

FLIGHT EXPERIENCES IN THUNDERSTORMS
REFLECTIVITY

"Never judge a thunderstorm by how it looks from the outside." That is an axiom which five years of flight testing has proven. Tops of thunderstorms may appear to be at a level that is often misleading. Formations which *appear* to be no more than 25,000 feet from a distance may prove to be well above the service ceiling of today's high performance jet aircraft. Some of the most vicious-looking storms proved to be real fizzles. Yet, other relatively innocent-appearing towering cumulous cloud formations were violent enough to cause severe aircraft damage. I am certain that in some of our penetrations loss of aircraft and crew was averted only because of the high caliber of ASD test pilots, coupled with the type of aircraft used as a test bed. Damage suffered by a T-33 that penetrated a mild-looking storm system is shown in Figure 2. Is there a way of knowing what storm systems may be penetrated safely without serious risk of damage or crash? YES!! What is it? Well, let me explain.

During Rough Rider '62, a T-33 penetrated a mild-looking thunderstorm. Note hail damage. Author says appearance no criteria.

During Rough Rider 61, the U.S. Weather Bureau's WSR-57 radar was used to examine storms. Incorporated with the WSR-57 radar was an alternate level banking contour circuitry. This attenuation feature provided simultaneous display of different levels of

echo intensity. Figure 3 shows the attenuation of five levels of echo intensity for a typical storm. Radar *reflectivity* factors have been derived from photographs of the plan-position indicator with the WSR-57 radar antenna elevated to illuminate the volume containing the penetration aircraft. Consecutive antenna scans are at 15 second time intervals and 6 db steps of the radar receiver sensitivity. The radar reflectivity is approximately proportioned to the precipitation constant squared.

This is all fine and dandy — but what does it all mean? Well, from Rough Rider 61 through Rough Rider 63 it was established that an F-100F aircraft penetrating a storm where the reflectivity (Z) was 10^5 or greater (Figure 3, Flight Path A) the aircraft would suffer structural damage. The degree of structural damage was dependent on the value of reflectivity. During Rough Rider 64, all the penetrations, except one, were vectored through the storm area where reflectivity was less than 10^5 (Figure 4, Flight Path B). Out of 128, I flew 127 successful penetrations without any damage to the aircraft.

It is possible, with proper radar equipment, for aircraft to be *safely* vectored through severe storm systems. But, remember this, a proper reflectivity value must be known for the particular type of aircraft being flown. I am certain that safe penetration reflectivity value is *not* the same for all types of aircraft.

On the one exception mentioned above, the reflectivity value was much greater than $Z = 10^5$. In fact, on that particular flight, I flew through the upper portion of a tornado that hit Yukon, Oklahoma, on 1 May 1964. The turbulence that I ran into was very severe, and maintaining aircraft control became my most important objective. This leads me into the subject of turbulence.

TURBULENCE

Personally, I most fear and respect turbulence over all other weather phenomena, and I think this is true of many pilots. Certainly, pilot discomfort and aircraft stress resulting from severe vertical gusts contribute to this philosophy. Present high performance airplanes are designed to withstand reasonably large acceleration loadings. They are not susceptible to structural failure under normal operational limitations. The key to safe turbulence flying is to stay within the normal operational limits of the airplane. But, we all know that flight conditions may exist under which this is easier said than done.

None of the airplanes flown by ASD pilots during Project "Rough Rider" were damaged by turbulence. The accelerometer in the penetration aircraft was repeatedly pegged in both directions. Yet, careful postflight inspections of the aircraft failed to reveal any signs of overstress. I remind you that aircraft accelerometers are usually over-sensitive to "jar type" accelerations. Under severe gust-like turbulence conditions, accelerometers do not always reflect actual stress loads on the airframe.

Further, we have not had a turbulence associated loss of control in any of the 564 penetrations flown since 1960. Proper aircraft control in a thunderstorm is a serious problem. Yet, from a controllability point, thunderstorm flying in a fast moving jet is probably easier than in slower moving prop airplanes — excursions in altitude, airspeed, heading and attitude are not nearly as great.

Now is an appropriate time to present an extract of a tape recording made during the penetration in which I flew through the top of a tornado (R.R. 44 is me; R.R. Control is Mr. Howard Murphy, an FAA Controller; Lt Miller is the test engineer who rode in the rear seat of the F-100F to record test data; time is in minutes and seconds after starting recorder).

TIME	SUBJECT	COMMENTARY
13:00	R.R. 44	"Now the turbulence is picking up just a hair . . . . Slightly more turbulence, the sky is getting just a little bit darker . . . . Turbulence is increasing."
13:30	R.R. Control	"Say again."
	R.R. 44	"Just a little more turbulence; the sky is getting darker . . . . Turbulence has increased to a moderate level now . . . . It's a nice steady moderate turbulence . . . Ah, it's a pretty good jolt there . . . . I'd start to call it rough now."
14:00		"Rough turbulence, some precipitation, looks like heavy rain, might be some hail in it . . . . Lightning strikes in the area . . . . We are encountering hail . . . . I definitely hear hail noise . . . . More lightning strikes . . . . Lightning strikes."
14:30		"Lightning strikes, severe updraft!!! Severe updraft!!!
15:00	R.R. Control	"Four four freq check."
	R.R. 44	"Rog, four four here."
	Lt Miller	"We're getting (BANG) ice on both the temperatures — (BANG, BANG, BANG-BANG, BANG, BANG — BANG)." . . . . CENTER LINE PYLON IS LOOSE . . . . SOMETHING IS BANGING —"
	R.R. 44	"Now, now."
	Lt Miller	"DIRECTLY UNDER MY FEET."
	R.R. 44	"now, now, now — that's just compressor stalls."
	Lt Miller	"OH! ha, ha, ha. Well, I'm a beginner."
	RR. 44	"Never mind."
	R.R. Control	"Four four freq check."
	R.R. 44	"Four four, — we ran into severe compressor stalls."
	R.R. Control	"Roger, you want to get out?"
	R.R. 44	"Yeah, if we can."
		again, left turn to a heading of three zero zero; three zero zero."

In narrative form this is what happened: Shortly after entry into the storm I encountered moderate turbulence. Then, simultaneously the sky got darker, turbulence increased and precipitation was evident. Next, as the turbulence became most severe — the precipitation (rain, hail, slush and snow) was the heaviest yet up to this time, a real wall of water — lightning strikes all around — we were in a severe updraft. As the airplane was being pushed up, the rate-of-climb indicator was pegged at 6000 feet per minute and the airspeed needle went from 275 knots to 394 knots. As I passed through 29 to 30,000 feet, I glanced out and saw that the wing slats were half out. Experience and airplane know-how told me it's not right to have half slats and a speed of 394 knots!! By this time we were passing 31,000 feet and the engine was in compressor stalls. It sounded like we were sitting on top of a machine gun and the pounding was enough to lift my feet off the rudder pedals. Tieing the compressor stalls in with the slat position, I suspected that the stalls were a result of too slow an airspeed. The altitude dial now read 33,000 feet and I started to push over to a 15-degree nose down dive. I had to get real airspeed not needle speed. While pushing over to keep from stalling, I turned on emergency ignition and emergency fuel to keep the engine from a flameout — all of this was going on at the same time that I was trying to calm my flight test engineer and still keep Rough Rider Control aware of what was happening. (This was the flight test engineer, Lt Ed Miller's, first flight test project. Ed had just been graduated from Penn State and was in the Air Force only three months before all of this happened.) Well, to continue, the airplane is set in a 15-degree nose down dive, the engine is at full power, and the airspeed needle smoothly turns counterclockwise and stops at 200 KNOTS. I'm now passing through 29-28,000 feet. By the time I pass 26,000 feet, the airplane is in a buffet and felt typical of speeds near 0.95 mach number. A glance at the airspeed needle, it reads 220 knots; a glance at the slats, they're full in; again this is not right!! I make a gradual smooth level off at 22,000 feet, set the airplane at level flight using the attitude indicator and adjust power setting for normal penetration airspeed. I exit the storm and the safety chase T-33 is there to pace me back for a safe landing at Tinker AFB, Okla.

As a result of a hail stone impaled on the end of the pitot tube and a pitot heater that did not work, I experienced about everything short of catastrophe, that may be experienced in a thunderstorm. Let us examine a few of these experiences, not necessarily in the order in which they occurred.

Compressor stalls: Compressor stalls, flameout or both is the most probable consequence of throttle jockeying and excessively slow airspeed at high altitudes, say above 30,000 feet. It is much safer to penetrate the most severe storm at the proper airspeed than to "flounder" into the top in a near stalled condition.

Airspeed malfunctions: If you have an angle of attack indicator, use it. (The F-100 wing slats act like an angle of attack indicator between their limits of movement.) If this instrument fails or you do not have one, use the attitude indicator. Fly attitude. Cross-checking with other instruments is the only way to detect incipient airspeed indicator failures. If the pitot tube is blocked you will have an increased indicated airspeed as altitude is increased and a decrease in airspeed with decreased altitude. However, do not confuse airspeed malfunctions with some airspeed increase when in heavy precipitation. Instead, this should be expected because of water injection effects. An increase in thrust is a result of the increased mass flow through the engine. A 10 knot increase in airspeed was a common experience.

Precipitation damage: Except for a couple of weak areas, most aircraft withstand hail quite well. I'd say damage caused by water erosion during supersonic

F-106 wing leading edge flush rivets that were peeled by rain impingement during supersonic penetrations of severe thunderstorms.

penetrations is more serious than that caused by hail, only because of the greater frequency of encountering water rather than hail. ASD engineers calculated the impact pressure created by water to be 18,000 pounds per square inch when flying at a speed of 1.6 mach number. This pressure will peel flush rivet heads out of the leading edge. (See Figure 4.) Plexiglass is worn down, fiber glass antennas eroded away and paint peeled or impinged off. To keep precipitation damage to a minimum, penetrate at the recommended air speed, not faster.

Turbulence: I am convinced that turbulence is in direct proportion to the amount of precipitation present. That is, when the turbulence starts to get heavy you can expect heavy precipitation, or when you start to encounter heavy precipitation you can expect severe turbulence.

Up to now I purposely avoided mentioning lightning because lightning is my last subject before closing.

LIGHTNING

Two years ago, on the east coast, a jet transport caught fire and crashed while flying through squall line thunderstorms at a low altitude. The possibility of a lightning-caused fuel explosion was raised in connection with this accident. The CAB found that the accident was probably due to lightning induced ignition of the fuel/air mixture in the Nr 1 reserve fuel tank with resultant explosive disintegration.

To measure electric field data and record lightning signatures inside and around thunderstorms was the major test objective of Rough Rider 64. Along with this test objective, we were asked by FAA to investigate the possibility of lightning igniting fuel vapor. A specially instrumented external tank and pitot boom was manufactured to collect data for this investigation. The F-100F test aircraft is shown during ground check in Figure 5. Our goal was to actually trigger or intercept lightning strikes and to record the lightning signature and overpressure of electrical discharges inside and around thunderstorms. As far as I know, this was an aviation first.

Some typical effects produced by a lightning discharge are: intense electric field and streamering, magnetic forces and fields, heating and blast effects and metal erosion. These are the forcing functions affecting airplane systems. I will not get into the mechanism through which charge separation and hence lightning occurs. I will briefly discuss the nature of lightning.

As a thundercloud develops, the potential difference between the cloud base and ground continually rises to a very high voltage (ten to one hundred million volts). When the electrical pressure gets too great, the air resistance is completely overcome and a torrent of electrons — lightning — passes to the earth below. (This occurs when a potential gradient of between 15 to 30 KV/om causes dielectric breakdown of the air associated with these conditions.) An average thunderstorm may fire 10 to 20 strikes of lightning per second. Each discharge lasts less than half a second and releases great amounts of energy (more than one million billion ergs). From a typical thunderstorm the total release of electrical energy may be in the order of 10 million kilowatts per second. This can result in peak currents from a *single* strike of greater than three hundred thousand (300,000) amperes and a total charge transfer of as great as one thousand (1000) coulombs.

Enough on the nature of lightning. To continue, I estimate the F-100F I was flying was struck more than 100 times during Rough Rider 64. Figure 6 shows some typical lightning damage. To answer probably the most interesting question you may have at this moment, we do not have any conclusive evidence that lightning will cause fuel vapor to ignite. I do not discount, at this time, the possibility of catastrophic fuel explosions resulting from lightning discharge. The space above the liquid fuel is filled with a mixture of vaporized fuel and air. The proper ratio of fuel vapor to air forms a highly explosive mixture.

There are at least five possible ways of an electrical discharge setting off a fuel explosion. They are: (1) a lightning strike burning a hole through the wall of the fuel tank; (2) a direct lightning strike to a fuel vent; (3) a strike to any part of the aircraft with the resulting high voltages causing arcing across the fuel vent; (4) adiabatic compressional heating in the fuel tank from a strike in the immediate vicinity of a vent; and (5) electrostatic arcing across the vent when the aircraft is flying in an intense electric field.

Unfortunately our instrumentation did not function as well as we had hoped. What data we did collect is still in the process of being analyzed. Project Rough Rider will continue in 1965; the instrumentation will be improved to get more conclusive data. One of the many things we learned during Rough Rider 64 was how we should improve our instrumentation to get the required data. But for this aviation historical first, we feel the entire program was very successful.

Ground check of lightning data collection equipment on the F-100F.

SUMMARY

In five years of participation in Project Rough Rider, the test pilots under the Deputy for Flight Test in ASD contributed immeasurably to flying safety for both civilian and military aviation. Some specific and unusual events discovered during the past five years are:

- Liquid water at 40,000 feet where the outside air temperature is well below freezing.
- Hailstones at 45,000 feet in completely clear air as far as five miles from the storm on the down wind side of the storm.
- Storms may build at a rate of 6000 feet a minute or greater.
- At high speeds, ice crystals or liquid water could cause as much damage as hail.
- Supersonic penetrations were possible and that bumpiness does not increase with speed as it does in the subsonic range.
- In areas of high electrical activity the 75 mc marker beacon light will flicker or glow brightly before an electrical discharge.
- Lightning strikes caused hair on head and arms to literally stand on end.
- Lightning is the most spectacular element encountered in a thunderstorm, the most startling, the most disturbing and right now the least understood.
- During severe turbulence proper aircraft control will require maximum pilot ability and techniques. Attitude flying is the only way you can hope to prevent catastrophic failure. Excursions in altitude and airspeed should not be chased. As best you can, maintain attitude and power settings for best penetration speed to ride out the storm.
- Finally, to repeat an old phrase — AVOID THUNDERSTORMS if at all possible. ★

Some typical lightning damage. The F-100 was struck more than 100 times during Rough Rider '64.

THE IPIS APPROACH

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

Q **On a flight from point A to B, you choose C as your alternate which is 400 miles from B. When arriving at B you are informed that the weather is below minimums. There are two airports within a 150 mile radius of B that are reporting weather of 700 feet and 10 miles with Radar available and PAR minimums of 100 and one quarter. If you decide to divert to one of these airports, must you still have enough fuel remaining to proceed to an alternate from the new destination and have the required fuel reserve of 20 minutes or ten per cent?** *(Captain Harry D. Hunt, Laredo AFB, Tex.)*

A Yes. In this case, diverting to the new airport is simply a change of flight plan. If your new destination weather requires that you list an alternate then you must do so and, of course, the fuel requirements still apply.

Q **PAR minimums at our base are one hundred and a quarter. If the weather is at minimums, I will reach 100 feet on the glide slope before I reach one-quarter of a mile from the touchdown point. Should I start the missed approach when I reach 100 feet, or can I level off and continue to follow the controller's instructions until I am over the runway threshold?** *(Captain John Carroll)*

A Remember, a PAR approach is designed to place you in a position from which you can make a visual landing. You should execute the missed approach procedure at minimum altitude as indicated on your altimeter or when the controller advises that you are passing minimums, whichever occurs first. Since the touchdown point is normally a minimum of 750 feet from the approach end of the runway you may not see the actual touchdown point when you reach minimums, but you must have sufficient visual contact to assure a safe landing.

Q **Is there a mandatory requirement that clearances be read back by the pilot?**

A Yes. In the case of ATC clearances issued by Air Force controllers, AFM 60-5 requires that the controller request a readback of the clearance to insure receipt as issued. However, if you receive a clearance direct from an ATC Center, a readback is not mandatory unless requested. Normally, acknowledgement that you received and understand the clearance is sufficient.

POINT TO PONDER

If corrective action is necessary when clear air turbulence is encountered what is the recommended inflight procedure?

The recommended procedure is to adjust airspeed to the proper turbulent air penetration speed for your type aircraft. If you have some advance warning that you are approaching an area of CAT and you can take steps to avoid it, by all means do so. However, the warning may be late in coming or it may not come at all. If this is the case, set the power to give you the recommended airspeed. Because of the turbulence you may not be able to maintain this airspeed but you can make smooth adjustments in pitch and roll by reference to the Attitude Indicator. During normal flight you should make corrections on your control instrument (ATTITUDE INDICATOR) when the performance instruments (Airspeed, Altimeter, Vertical Velocity, Heading Indicator) indicate a need for a change. During flight through turbulent air the performance instruments must be considered unreliable and the crosscheck can be limited to the Attitude Indicator. This does not mean that you should exert forceful control pressures to maintain a constant "picture" on the Attitude Indicator, instead you should make all necessary corrections smoothly and sort of "roll with the punches." This will help to avoid imposing extreme stresses on the aircraft and will help to prevent violent changes in aircraft attitude when going out of an updraft into a downdraft or vice-versa.

The use of trim must be considered carefully. Under normal flight conditions you should trim off pressures as the need arises. In flight through turbulent air the temptation to use large amounts of trim can be great. The best procedure is to set your trim control to the setting that will maintain level flight at the recommended penetration airspeed and leave the trim there. This applies to all aircraft and it is especially true in aircraft where changes in trim affect the position of the horizontal stabilizer.

Use of the auto-pilot in turbulence may or may not be recommended. Check your aircraft flight manual for the best procedure to follow in your aircraft. ★

WHAT MEETS THE THE EYE...

Real or Illusion?

The difference between appearances and reality can be not only mentally shattering but physically shattering as well. This is especially true if you are a pilot and fall for the deceptions created by various illusions present when landing an aircraft. Pilots are subject to many illusions, e.g., runway slopes, runway humps, width to length proportions, locations, size and brilliance of lights, contrast and background, convergence, light and shadow, and relative motion.

To review briefly, a pilot learns to fly using various reference points which for the benefit of this article will be called "illusions." The horizon "appears to be" even with the prop spinner for level flight. It is flush with the top of the nose on a normal approach and the pilot must pull back on the stick until the horizon cuts across the lower one-third of the cowl for a proper landing attitude. Different airplanes, different illusions, of course, but the principle is the same.

During training every pilot must learn to judge distance, direction and rate of closure. He must do this horizontally to arrive over the runway threshold at the proper altitude. He must be able to estimate height to determine the start and rate of flare; he must also detect lateral movement to compensate for drift. He must learn to blend these three directions and distances in order to land on the right spot, at the proper attitude and free from drift.

These are elemental aspects of flying. The simple truth is that until a pilot masters these skills he dare not solo.

It is basic that, in learning to fly, a pilot must first become proficient in visual flight skills. Then, and only then, can he progress to use of instruments and other aids. To this day, no matter how sophisticated the approach system, the pilot still must take over visually in order to flare and land his aircraft.

The pilot should always remember that instruments and navaids are merely *aids* to making an approach. At some point prior to start of flare he must rely on visual cues to land. He should also remember that, especially prior to the start of flare, he should use instruments and navaids to verify what he sees — or *what he thinks he sees*. The pilot who passes up the training value of having the ILS on during a VFR final approach is merely short-changing himself and everyone with him. He is passing up a free training opportunity and exposing all on board to unnecessary risk.

A study reported in this magazine last year disclosed that the leading cause of landing accidents was landing short. Yet it is a simple fact that staying on glidepath will prevent such accidents. In one tragic case the pilot was told to pull up, he was descending below safe limits. His retort, "I have the runway in sight." He crashed short of the runway, with a high fatality toll. The fact that the runway is in sight is no assurance of safe clearance altitude. From ground level, some runways can be seen several miles away.

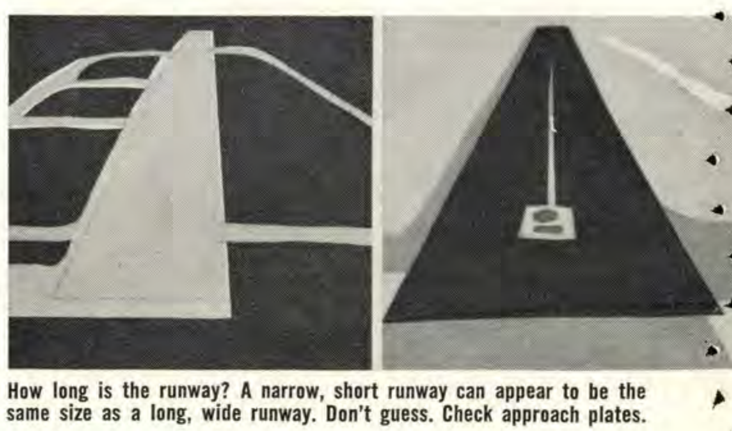
What the eyes sees may not correspond with conditions as they actually exist. A 150-foot — 5,000-foot runway will look like a 300-foot-10,000-foot runway, especially if few other objects of known size are close by. A bright light appears closer than a dim light. If two objects are the same size, the closer one seems larger.

The higher the cockpit above the runway, the slower the apparent speed.

Have you ever tried to spear a fish? You plunge the spear into the water and, if you aim dead center on the fish you get a clean miss. Because of refraction, the fish was not where it appeared to be. The same refraction problem shows up when you make an approach in rain. The runway appears to be lower than it actually is. The solution, obviously, is to heed instructions from the GCA controller and cross check other aids such as your ILS and altimeter.

Believing your instruments is every bit as important during flight close to the ground as it is at altitude. When visual cues are limited, or distorted as at night, in precip, over water approaches, approaches to snow covered airfields, only the careless rely on eyeballs alone. Ten years ago, a major command that was experiencing a rash of landing short accidents abolished straight-in approaches. Rectangular patterns were flown and, where available, instrument approaches were made mandatory. A 50-foot, over-the-threshold rule was invoked. Their landing-short problem was solved.

To use "illusion" as a convenient whipping boy to explain mishaps promotes rather than discourages ac-



How long is the runway? A narrow, short runway can appear to be the same size as a long, wide runway. Don't guess. Check approach plates.

cidents. As pointed out earlier, every pilot had to learn to cope with such appearances in order to solo. To cry "illusion" because an aircraft hit short of a 10,000-foot runway when less than half the 10,000 feet would have been adequate is absolutely unacceptable, especially for professional pilots. For years Air Force pilots have successfully flown large transports into Alaskan White Alice sites with runway gradients of as much as 12 degrees, few relative size cues and 4000 feet of gravel runway. STRICOM pilots perform exacting delivery operations into marginal airstrips. Navy pilots successfully touch down in a 120-foot distance on a canted deck that continually slides away from them. True, they have a "meatball" to use as an aid in staying on centerline and glideslope, but many Air Force bases now have VASI lights. Use them!

Early in 1965 a large Air Force bird was making an approach with a reported 100-foot indefinite ceiling. When the aircraft broke out, the crew tried to stop drift and line up by banking the bird. Touchdown was tiptank first. The tank ruptured, fuel streamed from it but fortunately did not ignite.

In 1964 a similar situation occurred, but with more serious consequences. Again the pilots attempted to line up after breaking out under a reported minimum ceiling. They crashed in the attempt, destroying the aircraft. They tried a maneuver beyond the aircraft's aerodynamic capability. In other words, had weather been CAVU and the aircraft positioned at the point where the crew took over visually, it would have been impossible to fly from that point to a safe touchdown.

When material was being gathered for this article an aviation physiologist (and a qualified jet pilot) commented, "Illusions, smillusions, we're looking for excuses in an environment every pilot lives with every day. The good ones — those who don't have accidents — aren't excuse hunters. They believe their instruments, operate within their limitations, and have the good sense to go to an alternate when conditions warrant. All illusions don't occur during landing."

Often after a taxi accident the pilot will report that "it looked like there was room." Last year a pilot landed gear up, on takeoff, when the plane became airborne on an upsloping runway; he retracted the gear, but the runway climbed faster than the aircraft. In precip or clouds, rotating beacons can cause confusion, even vertigo, dizziness and nausea. Helicopter blades can create a similar condition. Pilots flying in the North Country must fight off false horizons and other distractions caused by the aurora borealis. Fatigue, hypoxia, intermittent precip and clouds, stars, lights on the ground, no natural horizon and autokinesis (apparent movement) are conditions that aggravate illusions. Last winter a pilot was killed when his fighter crashed into a lake during a low altitude flight. The lake surface at the time was calm and reflected like a mirror. There is a strong possibility that this pilot was unable to judge his height above the surface and simply flew into the water. It has happened before.

The solution:

Knowledge. Know of these things and be able to recognize them when they occur.

Rely on your instruments. Instruments are immune to the phenomena that create false impressions in the human pilot.

Check landing distance charts, and believe them. When 3200 feet is required, and 10,000 feet is available, don't try to land on the first inch.

Check approach plates for type of runway lighting. Use navaids.

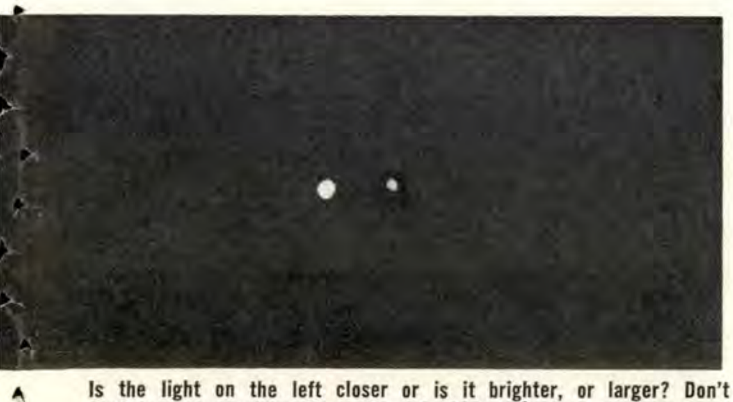
Have other crewmembers monitor, especially attitude instruments and altimeters.

Check approach plates for runway slope. When there is an upslope you will be lower than you appear to be. When there is a downslope you will be higher than you appear to be.

Abide by instructions from ground controllers. If warned you are low, pull up! Because of aircraft instrument lag and the fact that to the pilot appearances can be deceiving, instructions issued by the precision approach controller should be followed.

A lot of pilots have died proving the hazards of believing only what they thought they saw. And a lot more accident investigators have gone to great lengths to report such cases. The knowledge is there — only through blind ignorance, complacency and lack of self-discipline can such accidents continue to occur.

How sharp are your eyes? Did they catch the the title? ★



Is the light on the left closer or is it brighter, or larger? Don't trust your eyes alone. Use aids: ILS, GCA, altimeters, crewmembers.

Bug Smashers Can Be Safe

During the past year and one-half since this magazine last published a full-length article on aero clubs, a number of briefs have been carried in the Aerobits section, but, until recently, we've not taken a good look at overall performance. When we did, the look was encouraging.

The number of accidents during 1964 as compared to 1962, the last full year AEROSPACE SAFETY reported on, was cut by 50 per cent. Fatalities decreased even more. (Fig. 1). As the chart shows, some of the improvement must be attributed to curtailments in aero club activities overall. However, the big gain has to be credited to safe operations.

Another encouraging item was the number of clubs that received Flying Safety Awards from the Federal Aviation Agency. Forty-nine out of 108 clubs received awards.

Probably most convincing is the improved accident rate. Since no accurate record of flying hours was kept until recently, the past two years must be used for this comparison. For 1964, the aero club accident rate showed an improvement of 23 per cent over 1963.

WHO GETS THE CREDIT?

To what can we attribute the improvements that have taken place during the past couple of years? For one thing, a great deal of emphasis has been placed on factors contained in an article in this magazine for December 1963, "A Hard Look at Aero Clubs." Then there has been a tougher Air Force policy, generally expressed as "Shape up or close up." As a result, many deficient or marginal clubs which didn't "shape up" are out of business.

Probably the requirement that aero club accidents be investigated and reported, just like military accidents, has had a beneficial effect. At the very least there will be records which can be used to spot deficiencies and trends, a valuable tool for preventing accidents.

Another important factor in the improving aero club accidents picture is the effort put forth by the people in charge of aero clubs at the USAF Military Personnel Center, Randolph AFB. They've done much to get some organization into the aero club program. Their latest revision of AFM 215-4 Air Force Aero Club Manual is a blueprint for safe and efficient aero club operation. Their monthly poop sheets mailed to all clubs contain good information. In addition Major Jim Kiser and SMSgt G. F. Pollock Jr. visited more than 50 clubs last year. When they recommended that a club be shut down that generally was exactly what happened.

A big share of the credit must go to base commanders and the clubs themselves. The decline in number of accidents reflects better supervision by commanders and improved management on the part of club officers and managers.

OTHER SIDE OF THE COIN

All of the above is very encouraging but there are some blemishes on the other side of the coin. Last year there were 69 accidents and incidents, five fatal accidents and eight deaths. Cause factors are equally discouraging (Fig. 2): 52 were due to pilot factor. This far outnumbered all other factors combined. An encouraging thing was that only one accident was attributed to maintenance deficiency.

That pilot factor predominates is hardly surprising in a program comprising pilots of varying experience and competence (nearly half are students). Some accidents resulted from poor judgment, although it is often difficult to differentiate this from lack of experience. Others were brought about by poor technique, some by foolishness, some directly attributable to the pilot's low experience.

While we're on the subject of pilot factor we may need to look backward from the accident for the real factor. Were the actions of the pilot at the controls really to blame? It is obvious some students have been poorly instructed. So even if an accident is labeled Pilot Factor, it pays to take a closer look if we're going to prevent these in the future.

Among accidents that occurred last year were several ground loops and similar mishaps. Pilot factor? Yes, but was the student adequately trained in either avoiding crosswind conditions or in coping with them?

Cockpit unfamiliarity: Did the instructor, or check pilot, ensure that the person he turned loose with an airplane was intimately familiar

Fig I
USAF AERO CLUB STATISTICS

Year	Nr Clubs	Nr Members	Nr Aircraft	Total Acdts	Fatal Acdts	Fatalities
1960	180	15,000	814	75	10	15
1961	175	15,000	824	139	15	26
1962	159	10,743	760	109	10	21
1963	135	10,168	717	67	12	18
1964	108	9,428	547	47	5	8

Fig II
AERO CLUB ACCIDENT/INCIDENT
CAUSE FACTOR - 1964

Pilot	52
Maintenance	1
Materiel	12
Weather	3
Undetermined	1

with all the switches, knobs and levers? Obviously not.

Poor judgment: do instructors have the courage to recommend dismissal from the club of those individuals who demonstrate poor judgment and recklessness?

By far the greatest number of accidents last year occurred during landing. Nine of these took place with the gear up (all in the T-34), some because the pilot couldn't handle the wind, others in which control was lost for various reasons.

There were several mishaps due to cockpit unfamiliarity. For example, a student inadvertently put the fuel selector in the off position. In another the pilot grabbed the gear switch instead of the flap switch.

Then there were those in the damn-fool category. A sorry example was the fellow who buzzed a lake several times, much to the discomfort of boaters and water skiers, since at least three passes were below 50 feet. He then dusted off a camping area. Then apparently he tried a Split S and sucked it into a spin. The aircraft crashed and sank in 35 feet of water—the pilot was killed. This man had 500 hours and a commercial rating.

Whether this pilot had a history of such recklessness is unknown, but we're reminded of another case that occurred awhile back. This man ran out of gas trying to stretch a flight beyond the endurance of the aircraft. Although he was over mountainous terrain at the time, he lucked out and found a suitable spot for a forced landing. Sometime later this same individual took an aero club plane, flew to a nearby field and picked up two unauthorized passengers whom he transported to a city some 500 miles distant and returned them the following day. He didn't realize, however, that an employee of the aero club was at the airport where he picked up the passengers. This man reported to the club officers and the offending pilot was expelled from the club. Action taken after the first indiscretion would have prevented the second.

Bug smashers can be safe, but not when such items as this concrete block are overlooked during walk-around. It flew, to 50 feet, gear up, then ka-whop!

BETTER RECORD POSSIBLE

As indicated early in this article there has been tremendous improvement of the aero club safety record. But that doesn't mean we're in free. As of the end of March this year there were seven accidents and 17 incidents. In one accident there were four fatalities. To keep the accident curve going downhill, here are some recommendations from the aero club project officer in the Directorate of Aerospace Safety:

- Higher standards on the part of instructors. (FAA has agreed to flight check instructors at least once a year, more often if desired and workload permits.)
- Strict adherence to directives.
- Continued improvements in club management.
- Continued emphasis on maintenance. (Better inspection last year would have prevented incidents attributed to materiel failure.)
- Safety education programs at each club meeting.
- Clubs subscribe to General Inspection Aids Summary, FAA AC No. 20-7A, $1.25 a year, $1.75 foreign. This package includes the annual summary and 11 copies of the monthly General Aviation Inspection Aids. Another worthwhile publication is FAA Aviation News, $1.50 U.S., $2.00 foreign. These publications can be ordered from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Flying is generally considered to be hazardous. Most of these hazards can be removed for a club operation with proper management and good discipline and judgment on the part of members. In fact, we think light aircraft are a lot safer than your car. Anybody for the freeway? ★

To show you that fiction is stranger than truth, we present a monologue titled....

The 45 DAY WONDER

No, Virginia, its not that flying in itself, is so relaxing; it just seems so because of all the pilot goes through beforehand.

Just for kicks, come with a 100-hour-a-year administrative type. First of all, if he wants to fly (and you know we would never turn down flight pay) he'd better show some interest. Early in the month, like the first day, he ought to call the scheduling section and make two things mighty clear:

1. He wants to fly.
2. The days he is available.

O.K., so far. He should follow this up with occasional calls to show that he is really available. Fact is, he should even drop in at scheduling whenever he can – the personal touch, you know.

Then, when he does get on the schedule he should do two more things:

1. Plan to fly.
2. Resolve to not be too upset when he doesn't get to.

Once he's scheduled he's in for all sorts of trouble.

The plane may break down, probably this won't be known until after he has left Base Ops for the flight line.

A high priority requirement can come up (sorry, didn't anyone call you?)

The other pilot had his flu shots two days ago and is on the critical list.

By golly you're right. This must be the closed runway.

Sorry to bump you at the last minute but a full colonel up in headquarters needs time and this is his last chance before a long TDY.

Weather just went below minimums.

The pilot on the morning flight put the plane on a Red X. That's right, there is no backup.

Somebody got a flap with the fork lift.

. . . But suppose the schedule

holds. He shows up at Base Ops on time — a little early actually — because he always flys with guys who have to leave the office late.

Good thing he's early. The contractors who make a good living at perpetual remodeling have things in a real mess. Viz in the flight planning room is almost zero because of the dust. The whole room shakes as some clown with a jack hammer works his way along the

floor. Flight plans, clearances, performance cards, charts, maps, SIDs — all these are missing! They've been protectively hidden from the dust and the pilots. The dispatcher is on the phone. When he finishes explaining the procedure for getting on a military flight he will get the paperwork needed for flight planning.

Ah-ha! The NOTAMs are finally located — inside the latrine door — had to get things out of the dust. But the dispatcher can't be criticized, especially when he shakes his head and remarks how difficult it is to work a shift under such circumstances.

Finally, behind already by the clock, our pilot's ready — oops, almost.

Gotta get a local kit.

Gotta read the PIF — at least sign it.

Gotta sign some sort of sheet that says, in effect, the pilot certifies he is responsible for anything that might possibly go wrong.

Gotta get the weather extended.

Gotta get the crew bus driver out of the coffee shop.

Gotta change the SID. Can't use that departure with the VOR out . . . How would he know it's been out four days?

Gotta get briefed on the new form that shows passenger miles flown . . . of course it's mandatory.

At last.

Hi, Sarge, how's the bird?

What's that — gone after a power unit . . . hope he expedites . . . We've got to RBI if we miss take off time by over 15 minutes.

Oh, hi, glad to meetcha. You got on the clearance in Ops? Good. Yes, you can log nav time . . . four hours, I hope.

Aren't you Sergeant Foster? We got Airman Ryan on the clearance for engineer. O.K. But, remind me to call in the change when we taxi out.

Yes sir, Colonel, if you wouldn't mind. I'll get the inside.

SARGE!

Yeah, I wanted you. Both fuel gages inop, or haven't we been refueled?

Awright, but get 'em here on the double . . . better get oil, too.

No, I wasn't talking to anybody in particular. I was just wondering how we ever launch a missile when we have such a helluva time trying to get a Gooney Bird off the ground.

. . . Well, we got fuel and oil, and everybody on board, and the door closed, and the exterior, and the interior and the before starting checklist, AND the fireguard. Men, rap on wood, finger your beads, bow your heads — anything you feel might help — and TURN ONE!

Excellent start, men. Only two small backfires . . . that's right, Sarge, don't let 'er die, whatever you do. TURN TWO!

Hallelujah, they both run! Get the after starting, before taxi and taxi check. Wave the chock puller back . . . c'mon, baby.

Run-up check — and Sarge, be generous on those mag checks. This is my 45th day. If we don't get off today, I go non-current.

What's that, Colonel? Oh, sure, what'm I doin'? Trying to set the

altimeter by turning the artificial horizon cage button.

Oh, ha-ha, right one shakes a little. No problem. Drop is 80 and 100. Naw, Sarge, I read 50 and 60. Just looks more to you because of the angle. You've heard of parallax? Besides, we're light. Got beaucoup performance when it's cold like this. Don't worry, Colonel, they always smooth out at takeoff power. Try hittin' the mike on the window sill, sometimes that works.

By golly, you're right. This must be the closed taxiway, probably why they've got those barricades up ahead. Well, never be too proud to make the 180 . . . that's an old fly safe axiom. Let's see. Yeah, you're right. If we turn here ought to get to the active. Traditional I guess that this time of year some contractor is ripping up a section of the old airdrome. They probably got the world's best lobby.

Let's see now, SIF on Code 3, Mode 06 — or is it Mode 3, Code 06? Doesn't matter . . . anyone know where they've located the controls in *this* one? Well, imagine that, way over there. Congratulations, Colonel, doubt if I'd ever have located it.

O-o-o-oh kay, Sarge, let's get the rest of the checklists out of the way.

Colonel, tell 'em we're ready.

Tell 'em we're rolling.

Whats that, abort? NEGATIVE! It'll smooth out. Ease the power back a touch on the right one — nurse 'er, Sarge, nurse 'er. Atta boy. See, it's not backfiring now. Nice goin', Sarge. Yeah, Colonel, sure, Gear Up.

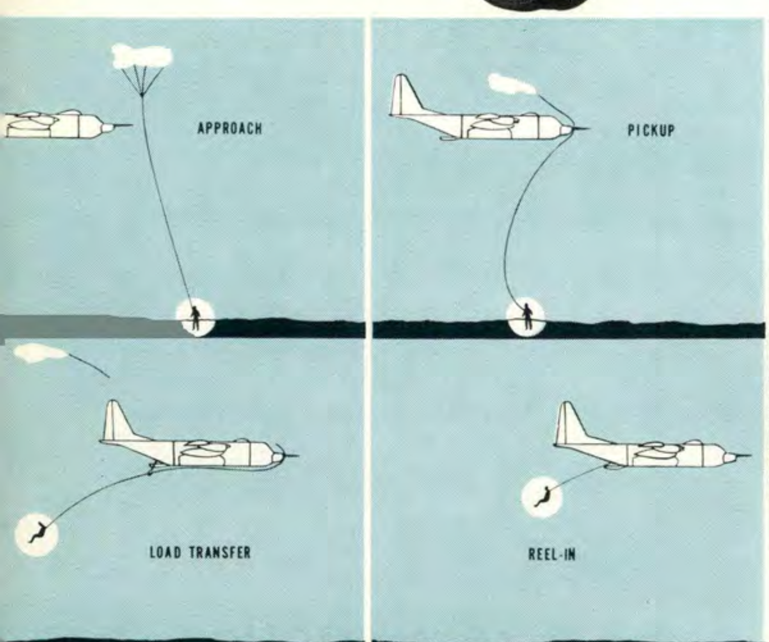
Boy, sure hope we can keep air borne for four hours.

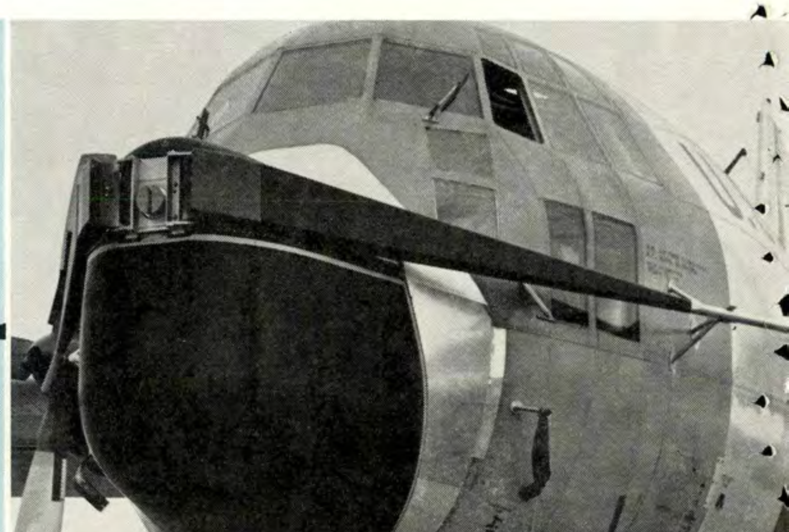
Howzat? Yes, sir, I'd like to shoot some landings, but boy, we don't want any aborts. Sarge, ease 'em up to max. Let's see how they . . . oh, oh, pull 'em back. Too bad, Colonel, if we ever land we'll never get off again. Tell you what, we'll get some practice approaches at altitude, intercept bearings, enter holding patterns, do a little practice airways flying . . . fella should keep up on his airwork too, ya know. Besides, the navigator has gotta get four hours too.

Howzat? No, sir, you can't volunteer for Category Three . . . I— a friend of mine tried. The best bet now is 45-22 and rottsa ruck! ★

MORE MUSCLE FOR RESCUE

Photo shows several features of HC-130H: Extended yokes, fending line from nose to wingtip, bulge on top of fuselage for spacecraft re-entry tracker gear.





During normal flight yokes fold back, as above. Pilot extends them when ready for an aerial recovery. Sky anchor can be seen at apex.

A new Long Range Aerial Recovery System designed to perform a variety of jobs ranging from rescue work to support of manned space launches and aerospace hardware recoveries will go into operation late this year with Air Rescue Service.

Heart of the system is the Lockheed HC-130H, a C-130 fitted with special equipment and more powerful engines than its predecessors. These engines, Allison T56-A-15 turboprops, are rated at 4591shp, although output is limited to 4200-shp. Special equipment includes a recovery system developed by the Robert Fulton Co., an overhead delivery system, multiple-tube flare launcher, reentry tracking system in a dome on top of the fuselage, and other electronic gear.

The most apparent part of the recovery system is a nose-mounted yoke — a pair of 15-foot aluminum probes mounted to form a V on the nose of the aircraft. A catch mechanism called the sky anchor is located at the apex of the yoke. The sky anchor locks onto a nylon lift line stretching from the person or object on the surface to be picked up to a balloon. Normally the yoke is positioned flush with the fuselage. When the pilot desires to make a pickup he extends it by use of a control in the cockpit.

In the event of a miss, the lift line is protected from the propellers by fiberglass fending lines 3/8 in. in diameter stretching from nose to wingtips.

Once the lift line is caught, it is up to the crew in the rear compartment to get the recovered person or equipment aboard. The lift line trails from the yoke under and behind the aircraft. This is hooked, the line pulled onto the ramp and secured. Then through a series of line transfers to winch assemblies, a snatch block and davit, the package—man or equipment—is reeled in and hoisted aboard.

Although the aircraft is unmistakably a C-130, there are a lot of differences: some, the nose yoke and fending lines, are evident, as is the blister on top of the fuselage. But the big difference is under the skin — the reentry tracking system; scanning stations on each side near the front of the rear compartment; a pair of 1800-gal. internal fuel tanks; an equipment bin for storage of recovery kits and other rescue gear. Redundancy is the word with the communications equipment — there are two of almost everything.

The HC-130H also features an overhead delivery system. The track runs along the top of the rear compartment to the aft cargo door. The 10-tube flare launcher is located in the door, which has a track on the outside that mates with the interior track to extend the delivery system beyond the ramp when the door is open. The winches are mounted on the floor near the aft end of the rear deck and the davit is stored nearby.

Various configurations are available according to the mission. Here are some possibilities:

- Visual search and recovery — radius of operation, 1500 nautical miles, search time one hour, two recovery operations.
- Orbit — radius of operation, 1000 nautical miles, orbit at optimum altitude for eight hours, two recoveries.
- NASA search and recovery — radius of operation, 2200 nautical miles, search time one hour, three recoveries.

Range was based on the distance between land bases for recovery of Apollo crews.

Normal crew is 10, two pilots, navigator, two flight mechanics, radio operator, two loadmasters, two pararescuemen. Provisions are made for augmentation by an additional pilot, navigator and radio operator.

A possible rescue mission, one pilot down in the water, would go something like this:

The survivor is located and a recovery kit is dropped into the ocean near him. The kit will contain a six-man life raft, a couple of helium bottles, a suit with an attached harness, 500 feet of 4000-lb. test nylon lift line and a 725-cu. ft. balloon which the survivor will inflate to carry the lift line aloft.

The man will get into the raft, put on the suit, fill the balloon with helium and send it aloft. The rest is up to the crew aboard the aircraft. The pilot's job is to intercept the lift line. A 100-foot section of the line near the top end is marked with pennants (lights for night recoveries). He flies upwind toward the lift line and extends the yoke. When the yoke hits the line it is locked into the sky anchor at the apex of the yoke and the man on the water is lifted practically straight up, the shock being absorbed by the nylon line. He is then gently hauled aloft and reeled into the aft section by the winch. He'll never forget that ride from brine to plane — the aircraft will be flying at 120-140 knots TAS nearly 500 feet above the surface.

Recovery kits differ depending on the number of persons to be rescued. For more than one person the kit will contain four helium bottles and 625 feet of 6000-lb. test line, (two six-man rafts for water recovery). The balloon will be larger — 1200 cu ft. Dual recoveries can be made with two suits fastened together.

Operational limits for recoveries are, wind up to 30 kts., temperatures +120°F to -65°, international sea state 3 (wind 13-18 mph, waves 2-3 feet high). There should be no obstacles over six feet high within a 50-foot radius and none over 50 feet high immediately adjacent. Maximum altitude is 10,000 feet; pickups can be made on a slope of up to 25 per cent.

Air Rescue Service is to receive the first HC-130H in July and replacement of HC-54's will be on a one-for-one basis. Crews assigned to the test program will form the nucleus of instructor crews at ARS recovery units where the aircraft will be assigned. ★

Malfunction Analysis

By Norman E. Borden, Jr., Operating Instructions Engineer
Pratt & Whitney Aircraft, East Hartford, Connecticut

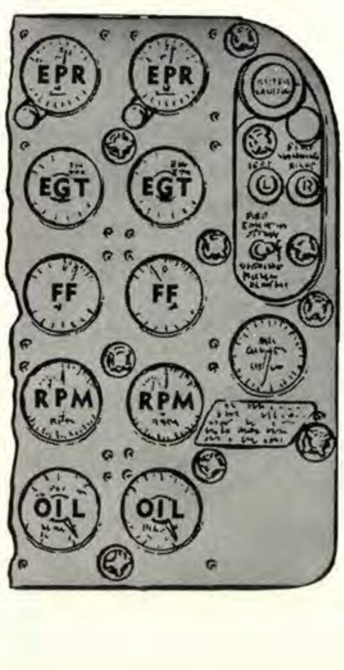
Early recognition of an engine malfunction followed by prompt and proper pilot action may be all that is needed to avert an accident.

As almost every pilot knows, literally millions and millions of flying hours have conclusively proved that today's jet engines are the most reliable power plants which have ever been built for aircraft. But the intrinsic dependability of the jets can boomerang and become a hazard if it is allowed to lull flight crews into complacency. The record of the jets is so extraordinary that many pilots take trouble-free engine operation practically for granted. Nevertheless, jet engines are still machines. As such, they are subject to occasional malfunction or, in rare instances, even to complete engine failure. Therefore, the possibility of engine difficulty in flight or on the ground cannot be ignored.

A controllable malfunction could conceivably become a serious emergency because of the attitude "it can't happen to me." This has, in fact, occurred many times as attested by tales of incidents which have been recorded from time to time on the pages of AEROSPACE SAFETY magazine. The axiom taught by such incidents is obvious. It behooves the pilot and crew who would meet trouble successfully to know in advance how to handle any situation which might arise in order that they may react almost instinctively when occasion demands.

Fortunately, jet engines actually speak a language. Talking through their instruments to pilots, flight crews and ground maintenance personnel who will listen by frequently checking and correctly interpreting the engine instrument readings, the jets communicate about how they are doing and they usually forecast a major malfunction well in advance of serious trouble. It is characteristic of axial compressor turbojet and turbofan engines that a change in the operating condition of an engine which causes a variation in the reading of any one of the four primary engine operating instruments (exhaust gas temperature or EGT, compressor RPM, engine pressure ratio or EPR and fuel flow) will also cause the other three primary instruments to vary. Conversely, when only one of the four primary engine instruments, by itself, indicates an erratic or abnormal reading, the cause is most likely an instrumentation system malfunction.

These four primary instruments (EGT, RPM, EPR and fuel flow) should be monitored simultaneously because the interrelationship of their readings at any given time provides the key for determining engine condition and diagnosing incipient trouble. Fuel pressure, oil pressure and oil temperature are not necessarily interrelated and may be monitored individually. A knowledge of what may be wrong when trouble comes will provide the best possible clue to the right course of action in each instance. Many situations can be quickly analyzed and timely measures taken if an engine's malfunction symptoms are understood. On the other hand, misinterpretation of apparent abnormal engine operation and subsequent improper corrective action may possibly cause a more serious situation than was present in the first place.



The guide to malfunction symptoms which follows represents a few, but far from all, of the circumstances which might occur to the afterburning engine, or engines, with which a fighter-type aircraft is powered. With the exception of malfunctions relating specifically to the afterburner, the same symptoms and their probable cause will normally also apply to non-afterburning engines installed in multi-engine bombers, tankers and transports. As an example of this, a similar, much more complete list of symptoms, their probable cause and the recommended action appears in full color in Section VII of T.O.'s 1C-135(K)A-1 and C-135F-1. The abbreviated list which follows here and the list in Section VII of the KC-135 and C-135 Flight Manuals were prepared by the author. The latter, being more comprehensive, is recommended for study by all who are interested, no matter what type of jet-powered aircraft they may be flying. Both lists are for axial single and dual compressor turbojet and turbofan engines manufactured by Pratt & Whitney Aircraft.

These malfuction guides are not intended to serve as maintenance trouble-shooting charts. To the contrary, the malfunction symptoms mentioned are only those which will be apparent to the crew in the aircraft. Similarly, the action recommended is only that which the pilot or crew may initiate themselves. Sometimes the only action a pilot can take is to shut the engine down or terminate the flight as soon as possible.

In the event of abnormal engine operation of any kind, the incident should be reported by an intelligent, accurate notation in the Form 781. Whenever possible, the engine instrument readings before and after the malfunction should be noted. Properly recorded engine discrepancies make for more positive malfunction analysis on the ground and for faster, better corrective maintenance.

Possible Malfunctions of the Basic Engine

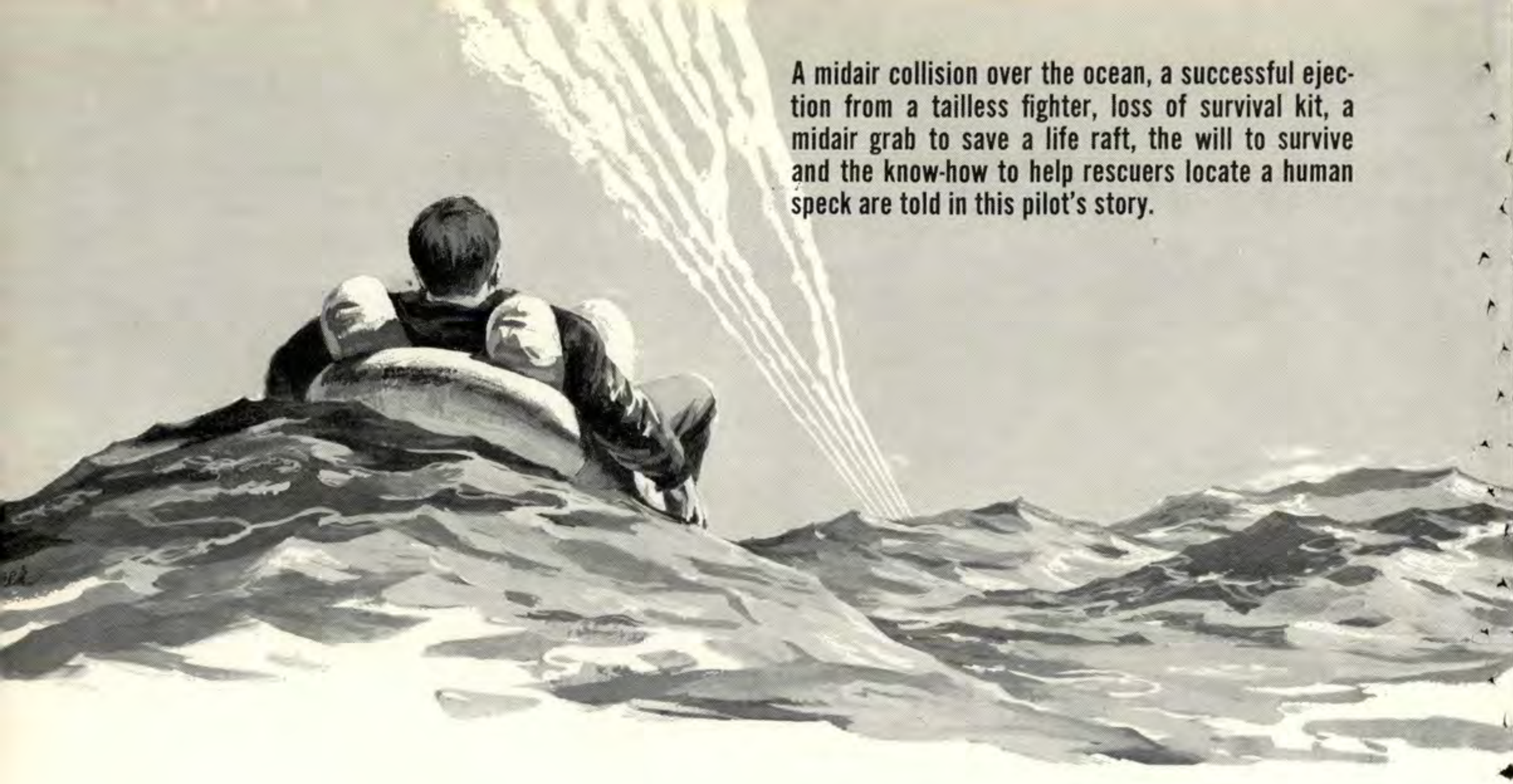
CONDITION	PROBABLE CAUSE	ACTION
TAKE-OFF ENGINE CHECK EPR at full throttle higher than computed. EGT, rpm and fuel flow higher than normally experienced for prevailing conditions.	Possible miscalculation, or use of incorrect temperature when determining take-off EPR Engine trimmed too high Possible, but not probable, fuel control malfunction	Recheck take-off EPR for prevailing ambient conditions. Continue with the take-off at the pilot's discretion, throttling back, if necessary, to avoid exceeding maximum allowable values for EGT, rpm and that computed from curves or tables in the aircraft Flight Handbook for the maximum EPR at the prevailing ambient conditions.
EPR lower than computed minimum for full throttle operation at prevailing ambient conditions.	Engine thrust deterioration due to deposits of foreign material on the compressor blades	Abort or continue the take-off at the pilot's discretion, depending upon the circumstances. Report engine for up-trimming or field-cleaning.
IN FLIGHT Drop in EPR, compressor stall (slight, snorting or very pronounced), possible reduction in fuel flow and, lastly, a rise in EGT as the condition continues. Rpm may or may not fluctuate, or it may drop if the condition continues.	If condition occurs during suspected inlet icing condition, possible accumulation of ice on engine air inlet section. Particularly if accompanied by compressor stall, may indicate engine ingestion of ice, with or without damage to the engine. Possible malfunction of automatic actuating system for the air inlet duct anti-icing equipment Engine ingestion of foreign object, such as a bird, with or without damage to the engine. If stall and/or high EGT continues, suspect compressor damage. If during or following an acceleration, suspect possible airbleed valve malfunction, particularly if stall disappears after engine has stabilized and instruments return to Normal.	If the condition occurs when ice might form in the engine inlet, turn engine anti-icing system "On." An increased throttle setting and/or a slower airspeed will increase the anti-icing heat and decrease the rate of ice formation. Observe EGT closely to avoid exceeding the prescribed limits. *The engine anti-icing system prevents the formation of ice and is not a decier.* Under the most severe conditions, it may be necessary to change the aircraft altitude or to locate atmospheric conditions that are relatively free of icing until the accumulation of ice has cleared from the engine air inlet. As soon as the engine commences to operate normally, the icing conditions may be safely re-entered. If a persistent stall occurs during or following acceleration and a stuck airbleed valve is suspected, reduce throttle setting and accelerate slowly. This may or may not be effective. **CAUTION:** *If internal engine damage is suspected or if EGT or compressor stall cannot be controlled, land as soon as possible, using the minimum thrust required to sustain flight.*
EGT too high, EPR lower than Normal, all other instruments approximately Normal	Excessive airbleed from engine due to: (1) Overboard airbleed valve stuck open, or (2) Excessive leakage in the aircraft bleed system.	Anticipate a higher than normal fuel consumption for the thrust produced until the condition can be corrected. Reduce the throttle setting, if necessary, to avoid exceeding the allowable maximum EGT. If overtemperaturing cannot be controlled, land as soon as possible.
Compressor stall during deceleration, often followed by a rumbling sound in the air inlet duct. Rise in EGT when condition persists.	Intercompressor overboard airbleed valves do not open during deceleration, due to: (1) Bleed governor schedule set too low, or (2) Bleed governor or bleed valve malfunction.	Increase airspeed to correct stall condition. Try switching to the emergency fuel system to control excessive EGT manually by the throttle setting. If overtemperaturing cannot be controlled, land as soon as possible.
EGT near Normal or low. Rpm, EPR and fuel flow low. Engine continues to operate.	Fuel control malfunction	Unless the condition is serious, no action is necessary except at the pilot's discretion. Report circumstances on Form 781.

CONDITION	PROBABLE CAUSE	ACTION
IN FLIGHT (Continued) Sudden drop in EGT, RPM, EPR and fuel flow. Complete loss of thrust.	Simple flameout, particularly when flying in turbulent air, resulting from upset airflow at the engine air inlet or within the compressor, itself. Flameout resulting from fuel flow interruption, possibly from running out of fuel. **NOTE:** Ignition operation should be for as short a duration as possible.	Attempt an air start. if this fails, attempt an air start on the emergency fuel system. Check fuel in tanks. Switch tanks, if necessary. Check position of emergency fuel shutoff valve. If cause was a simple flameout resulting from flying in turbulent air, try increasing the airspeed to prevent recurrence. Also, the ignition may be left "On" for short periods until the turbulent area is penetrated. This will serve to relight the engine automatically, in some cases.
Abnormal oil pressure	If the oil pressure gage reading is too *high:* Oil strainer is clogged, Oil pressure relief valve is not bypassing. If the oil pressure gage reading is too *low:* Oil level in oil system is too low, Oil line failure, Oil seal or bearing failure, Oil pump failure. **NOTES:** (1) A fluctuating oil pressure might be caused by any of the above causes. (2) Although a high, low or erratic oil pressure is frequently caused by a malfunction of the oil pressure transmitter or the oil pressure indicator, *it would not be safe to assume positively that this is the case.*	Normal oil pressure is 40 to 50 psi for most engines. Refer to applicable Flight Manual. Oil pressures between 35 and 40 psi are undesirable and should be tolerated only for the completion of the flight, preferably at a reduced throttle setting. Oil pressures below normal should be reported on Form 781, and should be corrected before the next take-off (i.e., do not practice touch-and-go landings). *Oil pressures below 35 psi are unsafe and require that a landing be made as soon as possible, using the minimum thrust required to sustain flight.* **CAUTION:** *If the oil pressure drops to zero and remains there for 15 seconds, or more, reduce the throttle setting to the lowest position required to sustain flight and prepare for the possibility of a seized engine within 2 to 4 minutes.*

Possible Malfunctions of the Afterburner

CONDITION	PROBABLE CAUSE	ACTION
As soon as the afterburner is turned on and ignited, EGT spirals upward. EPR will also be high. The condition may be (but not necessarily always) accompanied by compressor stall. On J75 engines, large drop in RPM when going into A/B with only a slight rise in EPR and EGT.	Afterburner nozzle fails to open or does not open completely when the afterburner is turned on and ignited. This might be caused by: (1) Binding of afterburner nozzle actuator pistons, or (2) Malfunction of afterburner exhaust nozzle control (ENC).	Discontinue afterburning immediately by deenergizing the afterburner switch in the throttle quadrant. If EGT exceeded the allowable limit, report the maximum temperature reached and the time that the temperature was overboard, on Form 781. Although the nozzle might open successfully if another attempt is made to light the afterburner, extreme caution should be used to avoid damaging the engine.

CONDITION	PROBABLE CAUSE	ACTION
AFTERBURNER (Continued) Conditions similar to those above, except less pronounced. EGT and EPR high as soon as afterburner is ignited. The condition may possibly be accompanied by compressor stall.	Afterburner nozzle is slow to open after afterburner is ignited. This might be caused by: (1) Afterburner "Off" and "On" operation repeated too rapidly, (2) Afterburner exhaust nozzle control (ENC) malfunction, (3) Afterburner nozzle improperly adjusted.	If the afterburner has been used intermittently, especially if a compressor stall condition has become aggravated by the afterburner having been repeatedly turned "Off" and "On," allow more time between shutting down the afterburner and commencing the next afterburner relight. The interval during which the afterburner is "Off" should be at least one minute. If the condition continues, further use of the afterburner should be at the discretion of the pilot.
Afterburner does not light up after afterburner is turned on. Condition will be noted by a lack of response of the aircraft and a sudden drop in EPR as the afterburner nozzle opens.	On J57 and J75 engines, fuel squirt from afterburner igniter and afterburner fuel flow from spray bars improperly timed, due to a drained afterburner fuel manifold Afterburner igniter malfunction Afterburner fuel control improperly adjusted Burner pressure line from diffuser case to afterburner meter leaking (possible but not common)	After leaving the afterburner "On" for 8 to 10 seconds, turn "Off" for 2 seconds, then "On" again for another lighting attempt. This technique gives good results because it changes the sequence of the igniter squirt and the afterburner fuel flow. The success of an afterburner light depends upon the igniter being timed to squirt when the afterburner fuel pressure in the manifold is increasing. If the squirt comes too late, the fuel/air ratio is too rich. If the squirt comes too soon, the ratio is too lean. When a fuel-circulating type of afterburner igniter is employed, the best recycling period between the first and second attempt to obtain a light is 3 to 5 seconds.
EPR too high during afterburner operation. Afterburner nozzle fully open.	Afterburner fuel control set too high Malfunction of fuel pump transfer valve or transfer valve actuator	If prior to take-off, abort or continue the take-off at the pilot's discretion. If the afterburner must be used for take-off, the take-off should be made at a reduced throttle setting, when possible, to maintain EPR within limits. If during flight, discontinue afterburning at the pilot's discretion.
Afterburner flameout in flight. **NOTE:** EGT and fuel flow will drop if afterburner nozzle remains in the open position after flameout.	An afterburner flameout in flight might result from any one of various causes, the most likely being incorrect fuel flow to the afterburner.	Try to relight the afterburner at a lower altitude and/or a higher airspeed.
EGT, EPR and fuel flow lower than Normal after shutting down the afterburner.	Afterburner nozzle stuck in the open position	Retard the throttle and then advance it again to the desired setting. This procedure will sometimes cause the afterburner nozzle to close. If the afterburner nozzle cannot be made to close completely, continue the flight at the pilot's discretion. ★



A midair collision over the ocean, a successful ejection from a tailless fighter, loss of survival kit, a midair grab to save a life raft, the will to survive and the know-how to help rescuers locate a human speck are told in this pilot's story.

Four Miraculous Hours

**By Capt Hosea L. Skinner, 3615 Pilot Training Group, Craig Air Force Base, Ala.
(Written while an FSO student at USC)**

Takeoff was at 0533. My wingman and I were to join the flight of six RF-101 Voodoos that were just approaching the island base and continue with them to our new station overseas. The climb and join-up were routine, and so was the first refueling more than 200 miles east. Then the climb back to 35,000 feet, the spreading out into ferry formation, and the long cruise climb toward the next refueling point.

As the flight leader was making his position report over the Coast Guard's Ocean Station vessel, I routinely looked at my left to check the position of my wingman. Surprisingly he wasn't there. I looked up, down, and behind, and still no wingman. As I swung my head back to the right I glimpsed over my right shoulder the nose of the biggest RF-101 in creation. Before I could react he gently slammed into my right upper fuselage. It sounded like the breaking of small boards, like the smashing of an orange crate. Then, complete chaos.

The tail of my bird was broken off and I started a backward tumble. Sitting foward of the center of rotation, I was held firmly in my seat, and during the tumbling I saw the other bird break in half and explode in a violent ball of orange fire. After six or eight tumbles my aircraft stabilized in a loose left spiral modulated by a fairly rapid left roll. Nothing on my instrument panel indicated problems . . . no fire warning lights, no generator out lights, no hydraulic warning lights, all needles in the green . . . nothing out of the ordinary. I could hear the other members of the flight now. "Look, they've had a midair!" "Lee, get out! Get out!" "Mayday! Mayday! Mayday! This is High Flight Charlie! We've lost two aircraft directly over the Ocean Station. Mayday! Mayday! Mayday! This is . . ."

My control stick was like a post driven in the cockpit floor, and for some reason I couldn't find the airspeed indicator. The continuous clamor of voices on the radio, coupled with the uncontrollable gyrations of my airplane, made the decision to eject an easy one. I keyed my mike and said, "I'll be getting out in a couple of thousand feet." Nobody heard me.

At about 34,000 feet I jettisoned the canopy and was surprised that no great blast of air hit me. Everything was peaceful and quiet, almost unreal. My navigation kit fell across my right leg, and I picked it up and tossed it overboard. Then, as my bird passed through the upright I ejected. I have no real memory of the ejection except that it seemed to happen jerkily, as do the old movies. Sometime during the ejection process I lost my helmet, but didn't realize this until much later. The seat and I separated, almost. My seat type survival pack was cinched to my parachute harness by two nylon straps, and the end of the left strap had flapped out and wrapped over, back under, and behind the left ejection handle. The task of loosening the strap looked simple, but with the seat and me flailing around in the airstream it was impossible. I reached for my knife, but it was gone. I reasoned, somehow, that in times of stress the supercharged human system was super strong — and perhaps it is, but I couldn't break the strap.

After what seemed an infinity it suddenly occurred to me that if I happened to be under the seat when my parachute automatically opened at 14,000 feet I'd had the course. It would rip me in half and keep right on going. Now what? I had to get above the seat, so I stuck one foot into the bottom of the seat, arched my back and stuck my arms and the other foot widespread into the airstream so that I'd rotate above the seat. As I passed through the horizontal I also passed through 14,000 feet. The next thing I knew I was hanging peacefully in the harness of the prettiest parachute in NATO. The ejection seat had broken free and was already out of sight below me. I began looking around, and saw both our aircraft crash into the ocean. Even in my peculiarly perilous position there was an unexplainable sadness about the death of the airplane. With his airplane goes a pilot's most precious contact with reality.

I sat back in my harness and looked down to check myself for damages. As I looked down blood spilled off my head onto my lap. I felt my scalp and got my hand covered with blood. Then nature took over and I forgot completely about my cut scalp and got on with my assessment of the situation. The chute and I were oscillating quite badly in the breeze, so I, as I had always been told by the survival specialists, pulled the risers to stop the oscillations. Immediately the chute collapsed. I turned loose the risers and the chute reopened, this time with a pop as loud as a shotgun. Frightened, I said, "To hell with it. I'll oscillate." Everything else seemed intact, so I pulled the lanyard that would inflate my life raft and let my survival pack fall down to the end of its 25-foot nylon lanyard. Then, as if not enough had gone wrong, the survival pack tore loose and plummeted seaward. As it tore loose it snapped the lanyard tight and the life raft, attached to the lanyard 15 feet above the raft, also tore loose and was thrown upwind from me. However, it inflated, turned over in the breeze, and floated back toward me. As it passed in front of me I grabbed it and held on for dear life.

About 20 miles away I could see the United States Coast Guard cutter sitting peacefully in that big, big ocean. It cheered me somewhat, for I was sure that rescue was not far away.

It seemed I hardly went under water on touchdown. After climbing in the raft and tying it to me, I looked up and knew the loneliest moment I will ever know. Thirty-eight thousand feet above me two of the eight arrow-straight contrails stopped abruptly, and the other six continued east without interruption. I knew that nobody had fuel enough to orbit and help in the ensuing search, but it was a terrible feeling . . . deep, painful, and transitory.

The little auxiliary survival packets on my underarm life jacket had medicine, flares, signal mirror, dye marker, shark repellent, and several other little goodies to provide the comforts of home. After washing my head with salt water and doctoring the two small scalp lacerations, I started keeping a chronological record that later entertained me immensely. When a Portuguese C-54 came over the horizon an hour or so later I knew that rescue was imminent, so I fired both my orange smoke flares, but the '54 made a left and then a right turn and kept going. It bothered me some, but strangely I was still sure that nothing bad would happen to me.

The surface winds were about 18 knots and the water temperature was 68°F — cool but not fatal. The Coast Guard cutter was busily steaming back and forth over the horizon, upwind, looking and searching. About an hour after the C-54 had come and gone, a WB-50 came charging over the horizon and continued out of sight downwind. The cutter also went from upwind to downwind, and 45 minutes later the WB-50 came back toward me. I threw out my dye marker, got my signal mirror working, and shortly the WB-50 was circling me and firing red flares to mark my position. Just over four hours after the collision the cutter put a longboat over the side and picked me up.

They had already picked up my wingman, and subsequent piecing together of the whole story brought out what seems to me as near a miracle as I've ever heard. After takeoff my wingman had not disconnected his zero lanyard, so on ejection at 38,000 feet he should have been killed by opening shock. He was still in the aircraft when it exploded, and that should have killed him. The loss of his helmet and oxygen mask in the ejection should have wiped him out from oxygen starvation. With only a summer flight suit and a light jacket on he should have frozen to death in the -69°F at 38,000 feet. And, when he lost his survival pack and his life raft he should have been impossible to find in all that water. In other words, everything was against him, but he survived. The most fantastic part of his survival is that the smoke from the flares I had fired had gone downwind and was directly over him when the WB-50 arrived. The WB-50 crew saw the smoke, went to it, and there was a very small floating object wildly waving a white scarf. To me —miraculous.

What did I learn about myself? I had always wondered how I would react under extreme emergency conditions, would I panic and completely drop the ball? I learned the answer to that in four of the longest hours of my life. ★

HOW NOT TO CELEBRATE THE 4th

He had paid good money for the firecrackers. But some had been duds. The fuses had fizzed, then gone out. The airman felt cheated. After he had shot off all the good firecrackers he still had the urge to do more celebrating. Besides, his son had been enjoying the fireworks.

Maybe they could still have some fireworks — homemade style. He and his son shook a small amount of the gray powder into a piece of paper. They then rolled the paper tightly around the powder. Gingerly they applied fire and a small explosion resulted.

Success!

If a little powder makes a small explosion, then it stands to reason that a more satisfying explosion would result with a lot more powder. Now for bigger and louder "firecrackers."

The self-styled pyrotechnists found a piece of half-inch galvanized metal pipe about four inches long. It had the general dimensions of a large firecracker and should be of satisfying size. They set to work. First they drilled a small fuse hole through the wall of the pipe about midway between the ends. They stuck a piece of tape over this hole temporarily to prevent powder from spilling out. Next they whittled a wooden plug and pounded it into one end of the "pipecracker." Carefully they opened the dud firecrackers and cleaned out the gray powder. When they had enough they poured it down the open end of the pipe. When they had a powder depth of about one inch they decided that should do it. They whittled another wooden plug for the other end. While his son observed from a few feet away the airman started to plug the open end by hammering the plug in on top of the powder. While he was hammering away with a ballpeen hammer the son voiced his curiosity, "I wonder if the pressure will make it blow—"

BLOOIE!

The blast tore off the middle, ring and little finger and about half of the palm of the airman's right hand. His son suffered slight lacerations of the left arm and cheek.

Neighbors drove the injured to an air station for first aid. They were subsequently taken to a general hospital for additional treatment. Later, under questioning, the airman explained how his plan had been disrupted by the premature explosion. Had he been successful in pounding in the second plug, he intended to insert a 12-inch powder filled plastic tube one-eighth inch through the fuse hole. He figured that the 12-inch "fuse" would provide adequate time to light the fuse and get a safe distance away.

Interrogation disclosed that he had no previous experience with explosives and was unaware of the fact that increased pressure could detonate the powder. ★

ABOUT USELESS THINGS

By Chaplain (Maj.) Frederick J. Ellis, Jr., Andrews AFB, Washington, D. C.

An old flyer once remarked: "The two most useless things in the world are the altitude above you and the runway behind you." I would like to add a third category to his list. I suggest as equally useless "The seat belt under you!"

The disadvantages of seat belts are their additional cost, the seeming inconvenience of buckling them each time you sit down in the car, and their annoying habit of seeking or shifting to an inaccessible spot under the seat or over the door sill. These and any others you can think of are far outweighed by the fact that they can save your life or the life of a loved one.

Why an expressed concern for seat belts in a chaplain's column? Because LIFE IS A DIVINE GIFT, given by Almighty God to man in trust and stewardship. No one has any right to do anything with life other than to use it in a manner pleasing to God.

Therefore any deed or misdeed that results in a lost or maimed life is contrary to the will of God and a breach of a sacred trust. Deliberate risk of life or inadvertent avoidance of a precaution, such as a seat belt, which will help safeguard a human life is not only foolish but immoral as well.

Seat belts are therefore not "extra" equipment but are by their very existence a mute reminder of a moral issue. ★

Missilanea

SUPER VISION? As the investigating officer walked out of the room after signing the accident report, one fact remained clear. The real cause of this accident was people — supervisors were not supervising. A stage 2 missile tank ruptured because of a negative pressure buildup. The negative pressure was caused by fuel leaking from a quick disconnect at a very high flow rate and the alleged improper action of an airman when he changed the position of the fuel tank vent valve.

Preparation for the download had proceeded normally, with an officer supervising the operation over the communication net. He had in his possession a copy of the approved checklist to verify that all required steps were being accomplished. It is interesting to note here that the supervisor was using T.O. 21M-HGM-25A-CL15-1 (Download), which was proper for this particular operation. But the two airmen in the equipment terminal were using T.O. 21M-HGM-25A-CL12-1, for uploading, in lieu of the approved checklist for downloading.

As the leak developed at the probe in the silo, a call fo: assistance was made to one of the airmen in the equipment terminal. When the airman arrived at the silo, he observed fuel spraying from the missile. Thinking that the fuel running from the tank would create sufficient negative pressure to collapse the tank, the airman decided to continue with the checklist and pressurize the tank as an emergency solution to prevent implosion.

I think the frosty topping was applied to this particular accident when the airman's commander stated: "I am convinced that his actions were taken in good faith, but his error in judgment, due to lack of knowledge of the possible consequences of the fuel vent valve closure, resulted in the rupture." Acts of good faith and errors in judgment are certainly poor substitutes for good maintenance practices; e.g., following approved technical da:a, technical competence, supervisory control.

The investigating officer attributed the primary cause to materiel failure; viz., a dislodged "O" ring seal which allowed the fuel to flow freely from the tank. He determined the secondary cause as personnel error when the airman closed the fuel tank vent, increasing the negative pressure already created by the leaking fuel.

The Wing Commander did not concur with the primary cause factor as stated by the investigating officer. The commander considered the airman's action to be a deviation from good maintenance practices. He further stated that "although the airman's actions were made with good intentions, he failed to check with his supervisor prior to taking any emergency action. Thus, the best systems knowledge, skill and judgment were not utilized."

Response of higher headquarters to the comment made by the Wing Commander relative to the airman's good intentions was: "The actions of individuals, during emergencies in missile environments, in good faith and with limited knowledge, have resulted in tremendous losses. 'Good faith,' 'he thought,' or any of the other often used excuses are not acceptable in the face of the extensive and continuous flow of directives stating that technical data will be followed."

The question is not whether the rupture occurred prior to or as a result of the airman's actions, but "at

what point was supervisory control lost and why?" My answer to this question would be that supervisory control was lost when the supervisor permitted deviation from the authorized technical order.

What was the authority for deviation from T.O. 21M-HGM-25A-CL15-1 in using T.O. 21M-HGM-25A-CL12-1 for download? How could the supervisor control the operation when some of the team members were using a different checklist?

You might say inadequate supervision. Another might say inadequate briefing. Still another might say insufficient know-how. In fact, all of these were touched upon to some extent in the investigation report. Also mentioned were such negative attributes as lack of common sense, deviation from tech data, and lack of good judgment.

The record shows many cases involving supervisory/personnel error. These all boil down to the fact that some supervisors are not putting enough supervision into their job of supervising. ★

Lt Col Adam F. Zalonka
Directorate of Aerospace Safety

THE MISALIGNED MISSILE

By P. M. Bowers, Minuteman Service News, Boeing Aero-Space Division, Seattle, Wash.

The missile was being removed from the launcher for recycling and had been hoisted completely into the fully-erected container when a packing nut failed because of hydrogen-embrittlement. The failure caused the left-hand actuator to break in two allowing the container to tilt and twist. The missile inside was moved out of position, breaking the stabilizing ring and coming in contact with the hoist sling rods and the top of the container. The incident occurred at approximately 2130 local time.

As soon as the incident was reported to Wing Headquarters, a survey team consisting of OOAMA and Boeing personnel (Boeing is the Assembly and Checkout Contractor for the Minuteman Weapon System) was dispatched to the site from OOAMA Headquarters. But there was little that this team or the SAC crew at the site could do until three heavy mobile cranes arrived some time later. The cranes were pressed into service as anchors for steel cables secured to the still-erect container to stabilize it against further displacement by anticipated high winds. Meanwhile, telephone contact was maintained with SAC and OOAMA Headquarters for approval of all recovery operations initiated at the site. With approval, an attempt was made with available equipment to reposition the missile slightly and lower it back into the launcher. This was halted when it became apparent that there was serious interference between the missile and some of the internal framework of the container. The fact that the stabilizing ring was broken was not known at this time.

Air Force personnel entered the container to evaluate the situation and work out corrective procedures. It was determined then that the stabilizing ring was broken and that the missile would have to be shifted back to its normal position relative to the container to permit its return to the launcher. To avoid the risk of damage to the missile from the application of correcting forces to points on the missile and the container structure that were not designed to withstanding such forces, the Air Force decided to obtain engineering assistance directly from The Boeing Company.

Boeing personnel at the site, with Air Force cognizance, had already reported the known details of the incident to their home office by 0830 the next morning and these had been brought to the attention of the

When the packing nut failed on a Minuteman transfer-erector hydraulic actuator, the resulting actions provided an excellent example of Air Force/Industry teamwork.

In photo at right cranes are used to stabilize against further shifting and high winds. Below, realignment was effected without missile damage and with no injury to personnel.

project engineers by the Field Service Unit, to which the report was made. The details were discussed during the day by means of conference calls between Boeing, OOAMA, SAC Headquarters, and 15th AF Headquarters. These were initiated by Ballistic Systems Division personnel who were at OOAMA at the time. The desirability of sending a Boeing engineering team to the site was considered during these conversations after it became apparent that the problem could not be resolved without special information unavailable at the site or in the standard supporting publications. By the time OOAMA formally requested Boeing to send such a team, four highly-qualified men had already been selected and given travel authorization — two from Structures Technology, one from the Design Project, and one, a metallurgist, from Materials Technology.

By 2100 the team had been flown to Wing Headquarters in an Air Force T-39. After a briefing by SAC personnel and a discussion of the Boeing proposals, the team was driven the 115 miles to the site, arriving at 0137 local time the following morning, less than 30 hours after the incident occurred and only eight and one-half hours after their presence had been formally requested.

The task of missile recovery was divided into three phases, with all activity proposed as a result of on-site decisions subject to approval first by on-site OOAMA personnel and then by SAC and OOAMA Headquarters by means of the communications network. Stabilization of the container, now designated Phase I, had begun as soon as heavy equipment, which had been dispatched from Wing Headquarters three and one-half hours after the incident, arrived at the site.

Steel cables had been attached to the container under-carriage and to the failed actuator attach point and anchored to the three mobile cranes that comprised the heavy equipment. By the time the Boeing team arrived, additional heavy vehicles and shoring timbers were at the site and were pressed into service for a revised stabilizing cable network.

Phase II called for bringing the missile back to a full vertical position, restraining uncontrolled lateral motion of the base, and installing a new stabilizing ring (one had been delivered to the site by helicopter). Phase III, lowering the missile into the launcher, had been attempted with minimum missile repositioning, but the procedure had been halted prior to the decision to bring the Boeing team to the site. The only continuing action at the site following cessation of missile lowering was to remove the broken stabilizing ring and take further steps to secure the container and the missile against displacement by expected high winds. Information as to the degree of displacement of the missile was sent to OOAMA Headquarters, with the opinion that lowering could be continued after the missile was realigned.

Realignment of the missile was begun by securing the missile base with several 5000-pound nylon cargo straps spaced around the launcher and attached to equipment room structure. By means of 1000-pound capacity portable winches attached to points on the missile and the carriages, the missile was moved far enough to permit installation of the replacement stabilizing ring. When the securing straps at the base of the missile were gradually released after the ring had been installed, the missile was properly positioned in the hoist sling rods and had adequate clearance from the sides of the container. Phase II was accomplished in approximately eight hours.

Phase III was completed in just under one hour, the lowering following the standard T.O. procedure except that movement was in short stages with a stop every five minutes for careful checks of alignment, clearance, and possible missile damage. Since the container was still out of alignment, the missile could not be lowered directly onto the base support ring. It was necessary for personnel to enter the bottom of the launch tube and swing the base of the missile manually in order for it to seat properly. The missile was safely seated on the receiver ring by 1714 and OOAMA and Boeing personnel were cleared from the site by 1733, slightly less than 48 hours after the incident occurred. The damaged T-E actuator was replaced the next day, the container was lowered, and the T-E was driven from the site.

The successful resolution of this unusual incident without damage to the missile or injury to personnel is a tribute to the quick reaction of military and contractor personnel and the high degree of technical cooperation that followed. ★

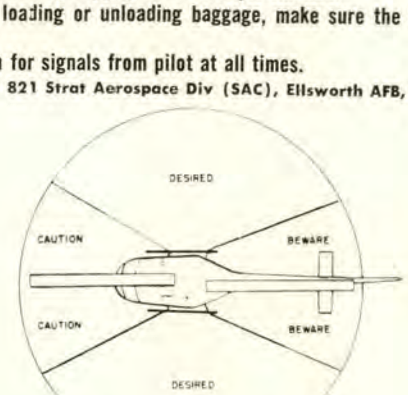
THE UH-1F HELICOPTER APPROACH AREAS

The UH-1F helicopter is fairly new in the Air Force inventory and chances are only a few people have had much association with it. The illustration here shows the approach areas; note particularly the potential hazards involved with this aircraft.

WARNING:

- **Do not approach when aircraft is starting up or shutting down. Main rotor can come as close as four feet to the ground in front of aircraft during this time.**
- **Do not approach tail when rotors are turning.**
- **Do not cross under tail boom.**
- **When loading baggage beware of jet exhaust.**
- **After loading or unloading baggage, make sure the baggage door is locked.**
- **Watch for signals from pilot at all times.**

821 Strat Aerospace Div (SAC), Ellsworth AFB, South Dakota

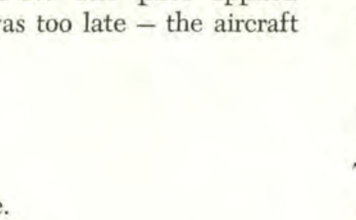


Aerobits

TAXIDENT — A C-97 was parked in front of and to the left of a transport. As the '97 started to taxi, the pilot was cleared to taxi straight ahead and then turn right to the taxiway. Instead, the pilot made a right-hand 180. As the aircraft came abeam of the transport, a transient maintenance man standing under the wing of the transport saw what was going to happen and signaled the pilot of the C-97. The pilot applied brakes but it was too late — the aircraft collided.

BRAKE SENSE — The accident related here was not caused by an Air Force aeroclubber, but it contains a lesson and similar accidents have damaged aero club aircraft. A Stinson, while taxiing, got bogged down in a mudhole at a civilian airport where an aero club keeps its airplanes. The pilot could not free the aircraft with power, so he set the throttle at fast idle, got out and pushed the airplane out of the mud hole. Free of the bog, the aircraft got away and collided with the tail section of an aero club Navion, causing extensive damage.

A similar accident occurred several months ago when an aero club pilot propped a Navion without first setting the brakes. The engine fired, the aircraft almost ran over the pilot, did run into a building. As of this writing the airplane still was out of service.



Never start an aircraft engine or permit one to be running without the brakes on. Better still, be sure a qualified person is at the controls and that the aircraft wheels are chocked.

KNOW YOUR LIMITATIONS — Eight hours after takeoff, the pilot called the local forecaster. Weather was reported as ceiling 100 feet obscured, three-fourths mile visibility and fog with runway visibility one mile.

Thirty minutes later, on final, the pilot was making the approach with the copilot monitoring instruments and watching for the runway to appear. Reported weather had deteriorated to ceiling indefinite 100 feet obscured, visibility one-half mile with light drizzle and fog, runway visibility three-fourths mile.

Upon breaking out the copilot took the controls while the pilot transitioned from instruments to visual flight. The aircraft was in a left drift, which the copilot attempted to stop with right aileron and rudder. The pilot assisted by pushing right rudder.

The right drop tank struck the runway. Landing was completed and when the aircraft had cleared the runway the gunner reported fuel leaking from the right drop tank.

The crew was lucky! This one ended up as an incident. It could have been much worse. We question the advisability of shifting control of the aircraft between pilot and copilot at this critical point in flight with a ceiling of 100 feet or less and visibility of less than a mile. Even more, we question the advisability of attempting an approach under such conditions. A much safer and wiser decision under such circumstances would be: *proceed to your alternate.*

Lt Col Harold E. Brandon
Directorate of Aerospace Safety

SAFETY PINS — A friend, Lt Col Frank G. Mitchell, former Chief of Safety at Edwards AFB, Calif., has called our attention to the fact that a number of transient aircraft have landed at Edwards without ejection seat safety pins aboard. Apparently the prime offenders are aircraft up for a local flight but which, because of an emergency, had to recover away from home base.

For the sake of crew safety, seat pins should be carried aboard the aircraft at all times. This also goes for external stores safety pins.

CURIOUS BYSTANDER — During a night training mission, a pilot was forced to eject from an aircraft because of engine failure. The aircraft landed on a farm.

Impact damage was not extensive and there was no fire damage so the aircraft was relatively intact. Due to the impact, the rear cockpit ejection seat was exposed and armed. Subsequently a curious bystander tampered with the seat trigger mechanism and actuated the rocket catapult, which caused the aircraft to be destroyed by fire. This precluded determination of the cause of the accident.

Fortunately, there were no injuries. If this had been an active combat aircraft rather than a trainer, the consequences could have been far more serious. Uninformed civilians might be expected to tamper with aircraft wreckage. Uninformed military personnel should not remain so.

Col Lawrence J. Pickett
Directorate of Aerospace Safety

INSTRUCTOR PILOT RESPONSIBILITIES — During the year 1964, instructor pilots were on board in three of the nine B-47 major aircraft accidents. Again, we are reminded that much has been said about the awkward position in which an IP is sometimes placed by a pilot to whom he is giving flight instruction. Specifically, when does the IP take control of the airplane?

This article is not intended to advise an IP specifically when to take over, but rather to warn him of the consequences of complacency or of allowing an erring student excessive latitude. Many of us like to think we have to fly like we drive our automobiles — defensively — constantly on the alert for someone or something trying to put us in jeopardy. And we try to stay ahead to allow for almost any contingency.

On the other hand, there are some pilots who are convinced that they can never be embarrassed by the idiosyncrasies of either man or machine. This attitude could easily be the first link in the chain of events that might lead to disaster.

It is difficult to believe that a highly experienced IP would allow his airplane to assume an abnormal nose-high attitude on takeoff and stall back into the ground. But this very thing happened — twice. Unfortunately, we are not able to ask the pilots "What happened?" because it was their final, fatal flight.

Many instructor pilots have traditionally believed that they were relatively immune from criticism while flying, and I do not intend to belabor the subject of complacency, but it does appear that this one item is again becoming a dominant factor in the accident picture.

Approximately four years ago a major command called in all its unit standardization pilots for some healthy discussions on aircraft accidents with instructor pilots aboard. During the previous year, IPs were on board the aircraft in most of the aircraft accidents, and some were extremely embarrassing. In one case an entire crew, IP included, bailed out of a large airplane when they assumed it to be out of control, but the airplane flew around for 59 minutes before it finally struck the ground.

In order to prevent aircraft accidents, every pilot, and especially the instructor pilot, must make an analytical evaluation of his personal proficiency, capabilities and limitations or he stands a chance of trading his wings for a wreath.

Lt Col David J. Schmidt
Directorate of Aerospace Safety

Aerobits

DAMP DRAG CHUTE PROBLEMS — Two F-84 pilots planned straight-in approaches and drag chute landings on a wet runway. In each case the approaches and landings were normal until drag chute deployment. In one, no chute was obtained. Later, on the ramp, the drag chute handle was recycled twice. The doors did not open, although the solenoid could be heard operating. The doors were then tapped and they opened. The drag chute was found to be saturated with water. In the other case the chute did deploy, at an estimated 120 knots. It blossomed, held momentarily, then collapsed as 11 lines broke. The chute was wet prior to deployment. Four of the broken lines were checked. They tested 300 to 1100 pounds over required tensil strength. Failure was believed due to excessive load imposed due to the moisture saturated drag chute. ☆

THE COLOMBIAN TROPHY

Awarded To The 612 Tactical Fighter Squadron, England AFB, La.

Lt Col Packard Larson, Commander, 612 TFS, receives Trophy from Mr. Marino Caiceda, Consul General, representing the Republic of Colombia.

The 612 Tactical Fighter Squadron, England Air Force Base, La., has been awarded the Colombian Trophy for 1964. This Trophy, a symbol of international friendship, is given annually by the Republic of Colombia to the USAF tactical unit having the most meritorious achievements in flying safety.

The 612 Tac Fighter Squadron compiled more than 17,500 hours in F-100 aircraft during the past three years while participating in full-scale deployments to Turkey, Clark AB, Philippines, and during combat support missions in Southeast Asia. During the latter, hazardous conditions included adverse weather during the monsoon season, mountainous terrain, limited facilities, and enemy ground fire. These conditions however, failed to deter the 612th in accomplishing its missions with safety, indicative of outstanding professionalism on the part of each crew member.

This achievement perpetuates the highest tradition and standards established for the Colombian Trophy and reflects great credit upon the 612 Tactical Fighter Squadron, the Tactical Air Command, and the United States Air Force. ★

☆ U .S. GOVERNMENT PRINTING OFFICE 1965 721-219/10

WELL DONE

CAPTAIN GARY K. CARROLL

71 FTR INTCP SQ, SELFRIDGE AFB, MICHIGAN

Captain Carroll was on takeoff roll in an F-106. He checked the airspeed, accelerating through 120 knots, engine instruments in the green. As he established his takeoff attitude, he heard a muffled bang and felt a jolt in the airframe. Rough vibrations followed. He checked his speed at about 140; better to continue takeoff than try an abort. He continued his takeoff, left the gear down and called Mobile. The mobile control officer thought the right main gear tire had blown. Another pilot on the taxiway confirmed Mobile's report. Cockpit indications were: all gear down and locked, hydraulic system safe. At that time Captain Carroll declared an emergency and flew by Mobile for a damage check. Mobile confirmed that the right tire had blown and most of the rubber was gone. Something was hanging; the right fairing door was pushed up against the wing. At that time Captain Carroll was concerned there might be some damage to the hydraulic lines. He talked with the safety officer on the ground and the director of operations and decided to make an approach end engagement. He asked for foam. The right side of the runway beyond the barrier was foamed as he expected pull to the right after hitting the barrier. He executed the approach end engagement as planned. The aircraft pulled slightly to the right into the foam and stopped with minor damage. WELL DONE! ★

USAF
pilot responding
most successfully
to an inflight
emergency

THE

KOLLIGIAN TROPHY

IS PRESENTED TO

Capt James W Anderson

Captain James W. Anderson, 27th Tactical Fighter Wing, Cannon AFB, New Mexico, was awarded the Koren Kolligian, Jr. Trophy for 1964 for his outstanding performance during an overseas deployment. Vice Chief of Staff, General W. H. Blanchard made the presentation during ceremonies in the Pentagon on May 7. The award was based on the following incident:

During the third leg of the deployment, Captain Anderson, flying an F-100, lost TACAN and ADF radios and his UHF transmitter, and his element leader lost all radios. In addition, stronger-than-forecast winds caused the aircraft to have less than predicted fuel at destination. Typhoon weather prevailed with the field below GCA minimums in a driving rainstorm.

On final approach Captain Anderson realized that his leader's UHF was inoperative so he assumed the lead and initiated a go-around. With his SIF he established with GCA that another approach was desired. With minimum fuel remaining and with no radio contact with his wingman and unable to talk directly to GCA, Captain Anderson led the flight to another approach. Upon reaching GCA minimums, he was still unable to see the runway because of the heavy rain. With insufficient fuel remaining for another approach, Captain Anderson continued down the glide path picking up the runway lights at less than a half mile from the runway. The aircraft completed a successful formation landing.

Captain Anderson is the eighth recipient of the Kolligian Trophy, established by Mr. and Mrs. Koren Kolligian, Cambridge, Mass., in memory of their son who was lost on a flight in 1955. The trophy is presented annually to the Air Force pilot judged to have responded most successfully to an inflight emergency. ☆