# AEROSPACE SAFETY

UNITED STATES AIR FORCE

October • 1962

**Landing With One Or More Gear Retracted**

*Major General Perry B. Griffith*
*Deputy Inspector General for Safety, USAF*

# PILOT FACTOR

CIRCUMSTANTIAL EVIDENCE has, all too frequently over the years, made the finding "pilot factor" mandatory. Ignored cockpit indicators, tower calls, mobile control flares and a horn at roundout makes a gear up landing a classic example—especially when followed by a satisfactory gear system check on a retraction test.

There have been others, similarly conclusive, and some where the evidence was not so strong.

This accident cause factor has been quite a stimulant over the years. It has provoked an alleged unfairness grievance rather general among pilots. It has probably prevented several accidents—safer decisions made because of fear of being charged with pilot factor. It has touched off some stirring rebuttals by desperate individuals. No other single cause factor can approach it as the object of accident prevention efforts.

In a way there has been an injustice. Others, just as guilty, have escaped this hated charge. Recently a severe control malfunction in a century series fighter was caused by a loose nut that had jammed in the control system. Here was a clear-cut case of "pilot factor," but not on the part of the man in the cockpit. And the "pilot" in this "factor" case wasn't pinned down. Was it the crew chief, an inspector, someone at IRAN, possibly even a workman at the assembly plant? Who can say how long a small foreign object can be carried before it is found, or causes trouble?

Incidentally, in this case the accident was avoided. The pilot's quick and accurate analysis and his professional skill enabled him to bring the aircraft in successfully. Nor was he the first to cope successfully with an emergency some other "pilot" handed him.

Now, particularly with pilot factor no longer the leading cause factor in aircraft accidents, added emphasis should be placed on this broader "personnel factor" category. And let me make clear that I am not speaking from the accountability standpoint. I am concerned from the prevention standpoint. I can't emphasize too much that behind the accident there is the man. He may be a long way back—possibly the man who failed to catch the flaw in the casting, or even the one who designed the casting—but somewhere along the line he triggered the sequence. The fact that he may never be singled out and adversely publicized, as pilots who err so often are, does not detract from his responsibility. Rather, the fact that this can be the case only adds to his individual obligation.

No one, knowingly, would cause an accident, nor put a pilot in a position of emergency. However, the crew fighting an inflight emergency finds its ordeal equally trying, whether the trap it is in is of its own making, or was set by someone some time before.

The solution? Spreading "pilot factor" preventatives throughout the "personnel factor" field. Strong supervisory concern will pay off. Emphasis on individual integrity, standardized procedures, thorough training programs and meticulous inspections will also help.

For those not involved in flight operations the probability of receiving credit for an accident prevented is even less than that of being charged with accountability for an accident caused. But the professional does not do his work for reward any more than for fear of reprisal. He does it right because that is the only way. ★

## IN THIS ISSUE



# FALLOUT

### GOOD MAINTENANCE—GOOD FLYING

I was reading about the T-39 Sabreliner in the August issue when I got sick—that is sick of the order in which you list possible trouble if $P_{T5}$ can't be achieved. I'm not a jet mech but we piston pounder mechs suffer the same agony.

You say that one of four things is wrong: 1. The computation was wrong; 2. Engine out of trim; 3. Sick engine; 4. Something wrong with indicating system.

I believe that step 4 should be #2 on your list, then pick up the order. It's been my experience that bad indicators have been the source of more troubles, heated arguments and sometimes downright fights than engine malfunctions. I don't mean to say that the power plant, piston or jet, will never fail, but I've had more low powers, MAP spreads, Hi & Low F/F's caused by calibration of instruments that were out of whack than sick engines.

Instrumentation is always a thing to check before blaming the power plant. It's just good practice to thoroughly eliminate indicator trouble before you go looking for engine trouble, otherwise all you have is a bunch of guage readings that don't mean a thing.

Well, I've let off a little steam. I enjoy reading your magazine. I work in Eng. Cond. mostly on C-124C and C-121C but all types of A/C through transient from all services and some non-service. This is one way to catch the weak points of lots of aircraft that we don't nomally see around here.

Thanks for listening to my gripe.

**SSgt David B. Henderson**
**1608 Field Maint Sq, Eng Cond**
**Charleston AFB, S. C.**

PS: I know this is primarily a maintenance problem but good maintenance makes for safe flying.

*Excellent point! Bad indicators make for uneasy pilots, too. The listing of four causes for inability to achieve $P_{T5}$ was not intended in any order of probability however. Another excellent point, "Good Maintenance Makes for Safe Flying."*

### COVER TO COVER

I've just completed reading the August issue and this is the first issue in many months that has been so interesting that I read every word from cover to cover. This issue made a liar out of me. Last week the Safety Officer from our neighboring RAF base visited my office to see what we had in the way of safety material. He was very impressed with Aerospace Safety Magazine; however, I told him that it had become pretty technical and not so interesting as the old Flying Safety had been. Then the August issue arrived. What a refreshing change.

I am sure you are getting many letters of appreciation on this issue. Our entire office staff wishes to say "Thanks" for the return to humorous food for thought which is easily digestible.

**Maj James B. Ross, USAF**
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*Your kind words are appreciated.*

### THE COVER

When the aircraft pictured on the cover had skidded on its nose to a safe stop on a foam-covered runway, off stepped the flying safety officers of the 551 Airborne Early Warning and Control Squadron and the 551 Wing.

Captain Morgan D. Childs, Jr., aircraft commander and squadron flying safety officer, and Major Howard A. Olsen, copilot and wing flying safety officer, were flying local when they discovered that the plane's nosewheel would only partially extend. For six and a half hours they circled, trying every possible remedy that the crew and ground personnel could think of. No luck. Finally, a tail-low landing was made on a foamed runway and the aircraft was eased over onto its nose in a maneuver Base Commander Colonel Ernest J. White described as ". . . one of the most specific examples of outstanding piloting I have witnessed in a long time."

Other crewmembers included Major Mile W. Bresley, pilot; MSgt Ralph Draper, flight engineer; SSgt Donald Lanham, radio operator.


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*So long as preventable accidents occur, there must be a safer way. The job is to find it.*

# SAFETY CONGRESS

THE tough, never-ending search for more effective ways of whittling away at the Air Force accident rate was the task. It was a big one. Accident rates approximated an all time low. To keep the rates down, and in an effort to lower them further, many of the top safety officers in the Air Force met at Sandia Base, New Mexico, 30 July. The occasion was the Third Annual USAF Safety Congress. The approach was a logical one. First, major problem areas, as disclosed by statistical records, were listed. Next, the conferees formed working groups to analyze thoroughly these problems and come up with solutions. Most of the major problems discussed, and some of the recommended solutions, will be reported here. A more detailed report, as a guide for the 1963 Air Force safety effort, will be reported at a later date.

PEP, for Personnel Error Prevention, was the motto selected for primary attention in the flight, missile, ground and nuclear areas. Lieutenant General William H. Blanchard, Air Force Inspector General and keynote speaker, underscored the appropriateness of the personnel theme by asserting that materiel—the number one accident cause factor—is designed, made and maintained by people.

He opened the Congress by calling for an adjustment of *attitude* as a means of accident prevention. Too many people, he asserted, take their mission too lightly, both on the job and off duty. He declared that we must develop a state of mind, and attitude, and behavior in the Air Force which will result in conduct conducive to accident prevention.

Major General Perry B. Griffith, Deputy Inspector General for Safety, pointed out in his opening remarks that 85 per cent of all accidents can be traced to personnel error. This problem, he said, calls for increased command safety emphasis. He cited three cases—electrocution when the tail of a towed aircraft struck a power line, electrocution when a crane struck a power line, and three dead when a missile silo door fell, after a shift change—as examples of need for greater command emphasis.

The automobile was cited as the No. 1 killer. In the 1961-62 fiscal year 413 airmen were killed from this cause alone, accounting for nearly one half of all fatalities.

One seminar was established to work on AFR 127-4. This single regulation, which was written to cover all safety areas, had experienced growing pains but, in the words of General Griffith, has been a considerable improvement over the previous system.

As in the past, seminar sessions were divided into four categories: flight, missile, ground and nuclear. Major considerations that were outlined in each of these categories included:

## FLIGHT

Reduction of jet fighter accidents as the action that would have the most impact on the USAF accident rate.

Materiel factor has become the leading cause of aircraft accidents due to: increased complexity of aircraft, older equipment, better investigation and analysis that has made possible more precise identification of materiel cause factors.

Lack of aircrew discipline contributes the greatest share of pilot factor accidents. There is need for improved supervision of aircraft in flight by ground based operations personnel.

Each safety staff must review mission profiles, procedures, briefings and critiques to make low level operations safer. During the first six months of 1962, 25 aircraft were lost during practice in this high exposure area.

Overflying maintenance capability cannot be condoned from a safety standpoint.

Tech order compliance, especially in aging equipment, must be accomplished fleet-wide. Also, after the T.O. has been rescinded, care must be exercised to prevent the same safety deficiency from again showing up in the aircraft.

Flight control problems, particularly in supersonic aircraft, are continuing.

Continued effort is required to obtain an angle of attack indicator for high performance aircraft.

Air starters are disintegrating. Better design is needed.

The greatest flight safety problem was cited as unreliable engines; critical in multiengine aircraft, disastrous in single engine. Over 300 major accidents have occurred from this cause alone since 1959.

## MISSILE

A three-fold objective of the previous year was listed as:

a. Integrating missile safety with weapons system conception, acquisition and operational management.


b. Refining and expanding the safety program to reach all activities.

c. Emphasize major air command safety program development from the inception of a missile or space vehicle weapon system.

The director of DIG/Safety's Missile Directorate announced that significant advances had been made in all areas of the 1962 program and that the most significant milestone was BSD's issuance of a MILSPEC that requires safety to be designed into weapons systems.

*In the human reliability* area personnel errors were credited with causing more than half of all missile mishaps in the past year. Among the reasons given were:

- Maintenance standards not as high as they should be.
- Adherence to checklists and procedures lacking.
- Supervisory responsibilities more demanding.
- Experience of missile supervisory and maintenance personnel much lower.
- Recommendations to alleviate these situations included:
- Verify configuration of equipment prior to use.
- Brief all concerned on the specific details of every task prior to accomplishment.
- Review tech data for each operation.
- Pay particular attention to cautions, warnings and emergency procedures.
- Return missiles and equipment to a safe configuration at the first indication of a malfunction.
- Use only authorized trouble shooting procedures, tech data and checklists.

*Inadequacy of available tech data* on a timely basis was cited as one of the most pressing problems. Specific criticisms listed were that too often technical information is incomprehensible, poorly illustrated, redundant or lacking essential information and clumsy to handle. However, it was pointed out that action has been taken to make technical publications more accurate, readable, suitable and convenient to the user.

New problems listed in the safety field include the hazards associated with attempting to meet scheduled completions. Shortcuts, ignoring safety criteria, proceeding without safety equipment and failing to verify subsystems prior to system tests were given as examples.

*Silo environment hazards* and potential hazards have evoked the following safety suggestions:

- Improved RP-1 vapor and diesel vapor sensing equipment.
- Protection of power production equipment and voltage switch gear from leakage and spills of fluids.
- Protection of LOX storage areas from leaks or spills of hydrocarbon fluids.
- Improved escape equipment and procedures.
- Adequate fail safe devices for all electrical, mechanical and hydraulic equipment.
- Improved emergency lighting.
- Elimination of electrical hazards caused by leakage of water into silos and condensation of moisture on silo structural members and equipment.
- Improved safety education factors caused by fear of toxic atmospheres and enclosed working and supervision.
- Improvement of psychological environment.
- Visual warning devices in high noise level areas for emergencies requiring personnel evacuation.

## GROUND

Although successes have been recorded in the area of ground safety, particularly in government motor vehicle operation, and even a slight decrease in the private motor vehicle accident rate (fatalities were up, however) specialists came to the conference with a list of problem areas that require renewed attention.

The "Personnel" in the PEP program that were listed as chief targets of the ground safety accident prevention goal were: commanders, supervisors and airmen and employees.

Ground accidents could be cut, it was indicated, if airmen and employees would take the trouble to walk to the hangar or the library to consult appropriate instructions. Further, if the instructions are still not understood, the supervisor should be consulted.

Supervisors could be more effective in preventing personnel error if they would recognize their responsibility. There have been occasions, it was pointed out, when supervisors have directed their people to perform an operation for which they have received no training. On other occasions airmen have been directed to refuel aircraft without bonding and grounding. The four essential elements a supervisor should employ in teaching were reviewed.

1. Explain how to do the job.

Air Force I. G.
Lt. Gen. William H. Blanchard
Opens Safety Congress,
Underscores theme:
Personnel Error Prevention.

# SAFETY CONGRESS
## (continued)

2. Demonstrate how to do the job.

3. Have the trainee demonstrate how the job should be done.

4. Follow up later to see that the job is being done correctly.

The commander is where safety begins. He must provide leadership and impetus. He must not expect performance beyond individual capabilities. When such a problem is encountered the supervisor or workman must be trained or the job given to a qualified individual.

The programed ground safety agenda included a broad range of subjects including such things as: education and training, investigation and reporting procedures, the motor vehicle problem, sports accidents, transportation of dangerous materials, explosives safety, parking and maintenance of explosives loaded aircraft, hoists and cranes, airless spray painting and materials handling.

### NUCLEAR

The Director of Nuclear Safety for the Air Force called for the assistance of all in order to continue the record of no nuclear explosion in any incident to date. He reminded the conferees that the nuclear safety program is a two part program—the first a thorough and comprehensive safety analysis of each particular nuclear weapons system; the second the establishment of effective and aggressive nuclear safety programs at all levels of command throughout the Air Force. He pointed out that in all incidents to date none have come close to producing a nuclear yield. He stressed that safety in design must be supported by safety in procedures throughout the stockpile to target sequence. In addition to this feedback of information, the importance of command surveys was stressed. These can disclose any deficiencies in safety rules, design features and supporting procedures.

Although prevention of accidental nuclear yield explosions was listed as cardinal, reduction of mishaps also was stressed. Mishaps, it has been found, can usually be traced to a lack of professionalism. The director called on increased professionalism as a reflection of Air Force competence, vital in the nuclear field.

### CONCLUSION

In concluding remarks General Griffith asked that all commands keep DIG/Safety apprised of problems and recommendations. If the command can't solve the problem, there should be no hesitancy in coming to DIG/Safety for assistance, he said. He predicted that the revised AFR 127-4 would be out by 1 January. He indicated that there would be a tougher attitude on surveys because of recurring discrepancies. All in all, he expressed approval of the progress made at the conference and predicted continued success in accident prevention with command implementation of congress recommended safety practices.

Nuclear Safety Seminar stressed two-part program: thorough safety analysis of each nuclear weapon system; effective nuclear safety program throughout Air Force.


# . . . . ROAD TO THE DUMP

THE MISSION WAS AIR EVAC, plenty of motivation here. The site, a Dew Line strip, about as remote as airfields can get. The aircraft, a C-123, an enlarged bush plane. The pilot was a 26-year-old IP who had the whole show on his shoulders; his copilot and engineer had never been into this site.

Weather to pickup point was cold, cloudy and bumpy, routine for Alaska. Over the radio beacon weather was checked as above minimums for letdown. The pilot started his instrument approach.

When you have only an ADF you can't afford one mistake, or even one failure of your nav system, especially when inbound over water into rough terrain. A backup was contrived; the radar operator would advise when the plane was three miles out.

Procedure turn was made and the aircraft headed inbound. Three miles; the shore line was in sight, but not the runway. The pilot continued his approach. He recognized a landmark that he knew was right of the runway and altered left. At approximately two to two and one-half miles the pilot announced, "I have the runway in sight." He cross-checked brightly painted barrels on each side of a strip of windswept gravel, bearing to the radio station and mag heading on final approach . . . never trust one aid when cross-check aids are available.

Final landing configuration was established. The gear came down, a noise level increase accompanied the pitch change and speed was slowly reduced. Descent continued.

A weather observer watching the approach, ran inside to make a call. This one didn't look right.

The moment of truth came at 200 feet. A quick doubt was immediately followed with certainty. This was not the runway! Someone had used fluorescent painted barrels to mark the road to the dump. At 200 feet and over 100 knots the decision had to be quick, and right. The pilot didn't hesitate. He made his decision and briefed the crew. "This is not the runway. I am going to land on the road."

This decision, though made almost instantaneously, was based on evaluation of alternatives. The pilot was well aware of the high, rock-studded terrain that formed the bowl into which he was proceeding. He was aware too that he didn't know his exact location in relation to the short gravel landing strip. And, low and slow, with everything hanging, the C-123 doesn't just suddenly get up and go. He was well aware of this, too.

Touchdown was made with the left main gear. Short field techniques were called for. Reverse. Brakes. Flaps up. Nose steering for directional control. As the aircraft slowed viz went to zero in snow blown around the cockpit by the reversed props. Some visibility was mandatory. Out of reverse . . . still on the 22-foot road . . . back into reverse.

He might have made it. The aircraft was going up hill and slowing. Then, just as they crested the hill, he could no longer help himself. The road turned, more than 60 degrees. He tried. He cocked the nose gear with the turn and jammed on left brake, but time had run out. As the aircraft crossed the crest all weight came off the nose gear. Left brake alone wasn't enough. The C-123 continued on course and as it left the road the nose plowed into the rock and snow embankment. The nose gear collapsed and was pushed back through the floor.

The medical technician, riding in the back, remembers thinking just after touchdown that this must be the roughest runway in Alaska. He braced himself, then watched survival gear heave forward against the tie down straps. Snow sprayed into the cabin through the nose gear housing. Next, the nose gear came through the floor, knocking over the box used for strap and chain stowage. Another few seconds went by. When certain the aircraft had finally stopped he evacuated along with the other crewmembers.

Investigators concluded that an attempted go-around could have been disastrous. Visibility was restricted in light snow and fog. Snow covered terrain features blended together. They stated that the decision to land was sound and that the pilot exercised "extreme skill and professionalism." ★

# LANDING WITH ONE OR MORE

THE HAZARDS OF LANDING with one or more gear retracted have caused many moments of anxiety, particularly among flight crews. Increased landing speeds of high performance jet aircraft have placed increased importance on the ability and sound judgment of the pilots.

Several landings have been made by KC-135 and similar commercial aircraft with one or more gear retracted. In some of these instances, failure of one or more gear to extend was apparent prior to the actual landing and the aircraft commander was faced with the decision to land with available gear or to make a belly landing. Passenger and flight crew safety was of primary concern. Structural damage to the aircraft was also given consideration. An analysis of the experience gained from these accidents indicates that landing with as much of the gear down as possible will generally provide maximum personnel safety and minimum damage to the aircraft. This recommendation is a part of the Emergency Procedures of the Flight Manuals applicable to C-135 and KC-135 aircraft.

An analysis of the possible types of gear up landings to be considered in this article reveals four various configurations:

- Nose gear unavailable. Both main gear down.
- One main gear unavailable. Nose and other main gear down.
- Both main gear unavailable. Nose gear down.
- Nose gear and one main gear unavailable. Other main gear down.

If it is determined that a particular gear problem is associated with the failure of either or both hydraulic systems, some alteration of the suggestions which follow may be necessary. Pilots should consider in particular what affected systems (such as pilot's brakes, copilot's brakes, C-135 rudder boost, inboard spoilers, outboard spoilers, and nosewheel steering) will apply to the landing roll control problem with which he is confronted.

All excess fuel should be dumped prior to landing. It is recommended that approximately 2000 pounds remain in each of the four main wing tanks (8000 pounds total) at touchdown, assuming a normal center of gravity. At low fuel levels which result in a relatively light aircraft, abrupt maneuvers, aircraft accelerations, and steep pitch attitudes should be avoided. Forward and aft body fuel tanks, as well as the upper deck tank on the KC-135, should be empty. Fuel dumping should be completed at least two minutes prior to touchdown to allow time for boom or dump tube drainage. The aircraft may be "cocked" for engine fire switch use after the loss of the generators on engine shutdown by placing the battery switch to EMERGENCY prior to turning final approach.

### • NOSE GEAR UNAVAILABLE

This is a case where, for some reason, the nose landing gear (NLG) cannot be extended or has been damaged during an initial touchdown. Both main landing gear (MLG) remain available to absorb the load at touchdown.

During a normal touchdown, the aircraft contacts the runway in a slightly nose-high attitude on both main gear. Therefore, a landing with the NLG up is no different from a normal landing until speed bleeds off and the nose drops. Ordinarily, the nose will be dropped deliberately to get the nosewheels onto the runway. This action reduces wing lift and improves braking. However, with no NLG available, the pilot should hold the aircraft nose slightly higher than normal. This will help reduce the landing roll as aerodynamic drag is greater in a nose-high attitude. In order to prevent the pod (body station 1300) from contacting the runway, the aircraft nose should not be allowed to exceed an angle of 8½ degrees above the horizontal during touchdown or ground rollout. The nose can be held off until the aircraft has decelerated to between about 70 and 110 knots. Higher speeds would be for heavier gross weights and a forward cg; lower speeds would be for lighter weights and an aft cg. These speeds are with the stabilizer set for a normal in-trim approach. Ordinarily, damage to the aircraft during a no-nose gear landing is limited to the nose gear doors, door frame structure, and gear actuator, provided the nose is lowered gently to the runway. The nose should not be held up so long and to such a low airspeed that it falls uncontrolled to the runway. The nose should be lowered gently to the runway while elevator control is still effective.

The copilot should turn off all fuel boost pump

Left, a KC-135 after coming to rest during a nose gear up landing. Right, typical runway foaming operations at a U. S. Air Force base prior to an emergency landing.


# GEAR RETRACTED

With one main landing gear gone, the aircraft rests on the two nacelles and the remaining main gear and nose gear. Damage is usually limited to the nacelles and engines. Prompt action in extinguishing any fire that develops at the lower part of the engine will prevent the fire from spreading. This is a commercial model Boeing 707 and is pictured here because of the similarity between this aircraft and the military KC-135 and C-135 for which similar results could be expected during this type of a landing.

switches and fuel valve switches just prior to the time the main gear contacts the runway. The speed brakes should be raised after the main gear contacts the runway. The rudder should be used to provide the directional control necessary to keep the aircraft in line with the foam strip which should be applied to the runway just prior to landing. A light steady braking pressure should be applied after the main gear contacts the runway. It should be noted that braking tends to pitch the nose of the aircraft down; therefore, normal braking should not begin until the nose has been lowered to the runway. Differential braking may be used, as necessary, to aid in directional control which is maintained with the rudder. The C-135B has the added advantage of reverse thrust which may be used at the pilot's discretion to reduce aircraft speed once the ground roll begins. With no nose gear on the runway, directional stability will be considerably less than normal. This will be especially true as the aircraft loses speed to the point where rudder effectiveness is lost.

The following sequence should be started as the aircraft slows down to a speed of approximately 40 knots:

- Pull engine fire switches.
- Throttles on the C-135A and KC-135A, or start levers on the C-135B, should be positioned to CUT OFF.
- Battery power switch should be positioned to OFF. The above sequence ensures switched DC power to close the engine fire shutoff valves. If the engines are shut down before the engine fire switches are pulled, thus losing electrical power, it will still be possible to close the fire shutoff valves by the following procedure:
- Pull engine fire switches.
- Battery power switch should be positioned to EMERGENCY.
- Battery power switch should be returned to OFF position after two seconds.

### • *ONE MAIN GEAR UNAVAILABLE*

With the NLG down, but one main landing gear (MLG) up, the one extended MLG absorbs the initial impact at touchdown without damage, as long as sink rates are moderate. In most normal landings, one main gear touches down slightly before the other, so this condition is not unusual. With full flaps and both inboard and outboard ailerons available for lateral control, the unsupported wing can be held off contact with the runway as the aircraft decelerates to between about 100 and 120 knots, depending on landing gross weight. With one main gear out of commission, the aircraft comes to rest on the two nacelles on the unsupported wing, the nose gear, and the one remaining main gear. Even with the inner cylinder and truck missing, and the outer cylinder of the damaged main gear extended, the end of the cylinder will not ordinarily contact the runway. Damage will usually be limited to the two nacelle structures. Unless the aircraft rolls onto soft earth and the nacelles touch down much lower than the one landing gear, the wingtip will not usually contact the runway or ground surface.

During this type of landing configuration, certain fire hazards must be weighed against the partial loss of hydraulic control associated with early engine shutdown or engine fire switch actuation. The following procedure, although somewhat complicated, retains full control while minimizing the fire possibility. Prior to final approach, the engine hydraulic oil fire shutoff valve DC circuit breakers for the engines on the ground contact side should be pulled. These circuit breakers are on the switched DC bus circuit breaker panel which is located just above and to the left of the boom operator's forward seat on the KC-135A or the additional crewmember's seat on the C-135A and B. Pulling the circuit breakers results in hydraulic output being unaffected until the engines stop, rather than when the fire switches are pulled for the engines on the ground contact side of the aircraft. Also, the battery power switch should be positioned to EMERGENCY prior to final approach. The pilot should make a normal approach, planning to touch down on the side of the runway opposite to the ground contact side. The copilot should pull the engine fire switches on the ground contact side and turn off all fuel boost pump switches and fuel valve switches just prior to the time the one good main gear makes contact with the runway.

Touchdown should be made in a normal wings level attitude on the good main landing gear. Careful attention should be observed in avoiding possible porpoising resulting from a nose gear first contact. The nose gear should be eased onto the runway gently. The speed brakes should be raised immediately to 20 degrees for maximum lateral control capability. This will ensure that when the pilot turns the control wheel to hold the unsupported wing up, the spoilers on the supported wing will extend to 60 degrees and those on the unsupported wing will return to fair with the wing surface. Unless speed brakes are first extended to 20 degrees, maximum control wheel motion will extend spoilers only 40 degrees on the supported wing. Directional control should be maintained by using the rudder and nose gear steering. Use as much braking as can be tolerated on the one good main landing gear to aid in directional control and also help slow the aircraft down.

First contact as the unsupported wing drops will be on the outboard nacelle structure. After the nacelle touches the runway, heavy braking on the one good main gear, as well as continued use of the rudder and nose gear steering, should be used to help keep the aircraft in line until speed is reduced and friction builds up between the lower nacelle structure and the runway. Reverse thrust of the C-135B on the two engines on the supported wing may be used at the pilot's discretion to aid in directional control.

The following should be accomplished as the aircraft approaches a stop:

a. Pull remaining engine fire switches.

b. All throttles on the C-135A and KC-135A, or start levers on the C-135B, should be positioned to CUT OFF.

c. If not already accomplished, the battery power switch should be positioned to EMERGENCY.

d. Push IN all previously pulled engine hydraulic oil fire shutoff valve DC circuit breakers.

e. After allowing the battery power switch to remain in the EMERGENCY position (step c above) for two seconds, reposition the switch to OFF. This will allow adequate time for closing of the engine fire fuel shutoff valve, which takes approximately one second to close.

As the aircraft comes to a stop, the drag on the nacelle structures on the runway will tend to pull the aircraft toward the unsupported side and possibly off the runway.

### • *BOTH MAIN GEAR UNAVAILABLE*

In the unlikely event that both main gear cannot be extended hydraulically or with the emergency extension system, a landing should be made with only the nose gear extended. A normal approach should be made, noting that any excessive speed will prolong the floating distance after the landing flare is accomplished. It should also be remembered that without the increased drag associated with main gear extension, the aircraft will have a tendency to float more after the landing flare.

The copilot should pull all engine fire switches and turn off all fuel boost pump switches and fuel valve switches just prior to touchdown. The landing flare, or roundout, should be made so that initial contact is made on the aft body structure with the nose slightly high, followed by lowering the nosewheel gently to the runway. This will avoid possible porpoising as a result of a nosewheel first touchdown. For initial contact to be on the pod (body station 1300), a nose-high attitude of at least 8½ degrees above the horizontal will be required.

The rudder, as well as nosewheel steering (if available), should be used for directional control. With the nose gear extended, a smaller area of the underside of the fuselage contacts the runway, thereby minimizing airframe structural damage. If the wings are kept level as long as possible, the inboard nacelles will sustain a major portion of the damage and minimize repairs necessary to the outboard nacelles. The following sequence should begin as soon as possible after the nosewheel has been lowered to the runway:

• All throttles on the C-135A and KC-135A, or start levers on the C-135B, should be positioned to CUT OFF.

• The battery power switch should be positioned to OFF.

The above sequence ensures switched DC power to close the engine fire shutoff valves. If the engines are inadvertently shut down before the engine fire switches are pulled, thus losing electrical power, it will still be possible to close the fire shutoff valves by the following procedure:

• Pull engine fire switches.

• Battery power switch should be positioned to EMERGENCY.

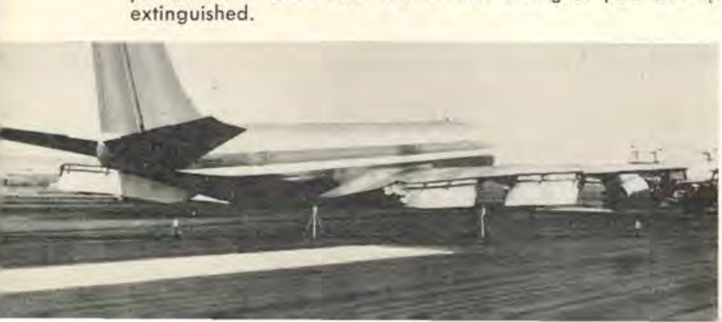
• Battery power switch should be returned to OFF position after two seconds in the EMERGENCY position.

### • *NOSE GEAR AND ONE MAIN GEAR UNAVAILABLE*

It is extremely unlikely that this type of landing will be necessary. However, it is possible that it could happen and, therefore, should be considered when discussing possible types of gear up landings. Greater protection for passengers and lesser damage to the aircraft can be expected by landing with one main gear extended than would be possible with all the landing gear up. Even one main gear absorbs part of the initial impact at touchdown through its oleo and will ordinarily keep that portion of the aircraft from contacting the runway. The procedure to be followed when in this landing configuration is a combination of those detailed earlier in this article under the sections covering *Nose Gear Unavailable* and *One Main Gear Unavailable*. The procedure is somewhat complicated but retains as much control as possible while minimizing the possibility of fire.

Just prior to final approach, the engine hydraulic

**After collapse and loss of both main gears due to premature ground contact short of the runway, the aircraft made a two-point landing on the nose gear and aft lower body. The inboard engine pods provided lateral stability. Damage to the lower aft body is shown in picture on right. Similar damage may be expected on a C/KC-135. Fire in No. 3 engine pod was quickly extinguished.**



**Lower aft fuselage damage to the aircraft shown at left resulted from landing with the nose gear down and main gear off. Sliding 5200 feet on dry concrete caused wear of skin and longitudinal stringers but minimum damage to fuselage frames. There was no evidence of fire in the area. Landing a C/KC-135 under similar conditions would result in the fuselage contacting the runway at the pod and between stations 1040 and 1120.**

oil fire shutoff valve DC circuit breakers for the engines on the unsupported side should be pulled. Now hydraulic output will be available until the engines stop, rather than when the fire switches are pulled. The battery power switch should be placed in the EMERGENCY position just prior to final approach. The pilot should make a normal wings level approach, planning to touch down on the side of the runway opposite to the unsupported wing side of the aircraft. The aircraft nose should be held slightly higher than normal at touchdown. The copilot should pull the fire switches for those engines on the unsupported wing and turn off all fuel boost pump switches and fuel valve switches just prior to the time the one main gear makes contact with the runway. Touchdown should be on the one main gear. The speed brakes should be raised to 20 degrees as soon as possible after touchdown for maximum lateral control capability. The nose should be held slightly high during initial rollout to aid in slowing the aircraft down. Also, a light steady braking pressure may be applied at the pilots' discretion to further aid in reducing the aircraft forward speed. Caution should be exercised to make sure no sudden brake pressure is applied, because braking tends to pitch the nose down. Reverse thrust on the C-135B may be used at the pilots' discretion. The rudder should be used to maintain directional control which, at best, will be considerably less than normal. Control characteristics are such that the nose can be held off the runway longer than can the unsupported wing. However, if the nacelles on the unsupported wing are allowed to contact the runway before the nose is lowered, the nose could be pitched down rather suddenly, which would increase the chances of structural breakup of the aircraft. Therefore, the nose should be gently lowered to the runway just prior to the time the engine nacelles on the unsupported wing are allowed to contact the runway. After the nose and engine nacelles have made contact with the runway, heavy braking on the main gear may be used as necessary to aid the rudder in maintaining directional control.

The following should be accomplished as soon as it becomes evident that directional control is about to be lost:

- Pull remaining engine fire switches.
- All throttles on the C-135A and KC-135A, or start levers on the C-135B, should be positioned to CUT OFF.
- If not already accomplished, the battery power switch should be positioned to EMERGENCY.
- Push IN all previously pulled engine hydraulic oil fire shutoff valve DC circuit breakers.
- After allowing the battery power switch to remain in the EMERGENCY position for at least two seconds, reposition the switch to OFF.

The chances of the aircraft ground looping as it comes to a stop are increased when landing on only one main gear. The drag of the nacelles and the nose structure on the runway will pull the aircraft toward the unsupported side and, even if a ground loop doesn't occur, the aircraft may come to rest off the runway.

### • *USING FOAM*

Use of foam under some of the conditions noted is recommended. This is predicated on certain assumptions:

- There is an adequate supply of foam and equipment.
- Enough foam is retained to extinguish any flash fire that might develop after the aircraft has come to a stop.
- Landing is made as soon as possible after the foam has been laid.
- Use of foam on the upper wing will not interfere with the egress of crew and passengers through the over wing escape hatches.
- Emphasis is placed on putting the foam where the aircraft will stop. It is far better to land on a dry runway and slide into the foam than to land in the foam and run out to a stop on dry pavement.

As for specific cases, the following recommendations are made:

NOSEWHEEL UP. A narrow strip about 15 feet wide permits the nose to slide in the foam while maintaining normal braking action with the main gear. Since a longer rollout can be expected with nose being held off longer than normal, foam should be laid beginning four to five thousand feet from the approach end and extending about 5000 feet or to the end of the runway. Landing should be about 1000 feet from the end of the runway on the main gear with the nose being held off for about 3500 feet before it is allowed to contact the ground.

MAIN GEAR UP, NOSE GEAR DOWN. A foam strip 130 feet wide should be applied beginning about 1500 feet from the approach end of the runway. It should continue for four to five thousand feet or to the end of the runway.

In case of one main gear up and the nose and other main gear down it is difficult to anticipate contact areas and the aircraft skid path after nacelle contact. Therefore, foaming is considered impractical. However, foam trucks should be in a position to pace the aircraft and follow it to rest. A small fire at the bottom of each engine nacelle on the unsupported side should be expected. Extinguishing the blaze immediately will control the fire because the fuel supply is cut off in the dry bay area of the wing.

With the nose gear and one main gear unavailable it is also considered impractical to foam because it is not possible to predict with any accuracy the path of the skid. The recommendations in the preceding paragraph also apply in this case.

As has always been the case, landing with only part of the landing gear extended constitutes an emergency. Landing multi-engine jet aircraft with part of the gear up is similar to landing emergencies experienced in past years with multi-engine propeller aircraft. Landing speeds and weights for jet aircraft are considerably increased over those for propeller aircraft. The heavy wing and body structure around the wing joint are built to withstand flight loads at high speeds and are also an aid in preventing a wing breakup during a gear-up landing. Landing with all available landing gear extended provides maximum protection for personnel and results in the least amount of structural damage to the aircraft. Consequently, Boeing's recommendation is to use as much of the landing gear as possible during any landing on any kind of surface except during a ditching in water. This recommendation also covers those cases where one or more of the landing gear might be stuck in a partially extended position. ★

*"Please watch for other aircraft."*

# MIDAIR COLLISION

ALTHOUGH the airplane has been around for nearly 60 years and has advanced from a bundle of sticks and wires to a computer with wings, the pilot's tools for avoiding a midair collision are still pretty rudimentary. He has ground control, including radar that provides lateral separation only, the eyeball system of see and be seen, and paints and lights to make the aircraft more visible. These are all limited as to effectiveness.

Since radar does not provide altitude information, the pilot is denied positive knowledge in that dimension. Nevertheless proper spacing laterally and vertically by ground control and the hemispheric system protects aircraft most of the time. Having bearing, too, is that what pilots *should* do and what they *do* do is not always the same. Some of the problems are improper altimeter settings and errors, sloppy flying that permits an aircraft to vary from its proper altitude, poor maintenance of headings and improper attention to the effect of wind. Any one of these may result in an aircraft's being out of position even if it is on the button time and speedwise.

The see-be-seen system has serious limitations but we have to rely on it most of the time. The first problem is to detect the other airplane. Then it is necessary to determine whether the two aircraft are on a collision course. Having made this determination, if a collision is indicated a proper avoidance maneuver must be decided upon. Then that maneuver must be executed.

Factors involved include, among others, the following: angle of approach, rate of closure, altitude of the two aircraft and time of detection. All of these must be considered in determining the avoidance maneuver. Important in this consideration is detection, or at what distance the other aircraft can be seen. Conspicuity paint and lights help to make an aircraft stand out and assist the pilot in spotting of intruder aircraft. These aids to detection, however, are seriously limited.

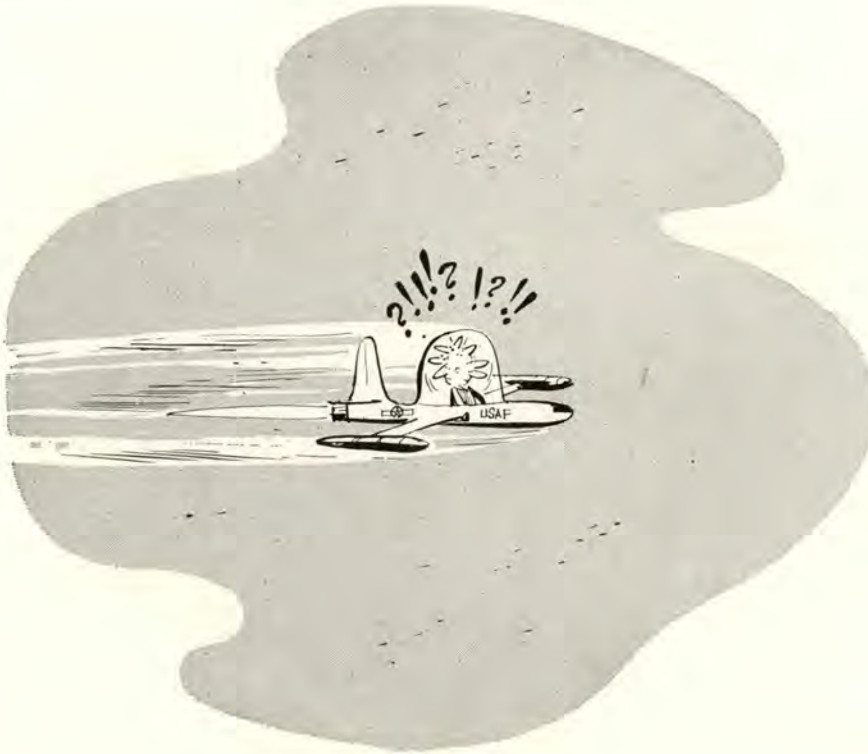
For several years the Federal Aviation Agency and equipment manufacturers have been experimenting with means of collision prevention through the use of airborne proximity devices. Statistics indicate that the midair collision is a serious problem and that such devices are needed. Since 1938 there have been nearly 450 midair collisions, of which 229 resulted in 874 fatalities. The most recent figures that point to the seriousness of the potential midair collision problem are from an interim report based on the first 10 months of Project SCAN, a survey of near midair collisions conducted by the Flight Safety Foundation under FAA contract. Of the total number of reports received, 1708 were considered "critical" or "potential" incidents.

Most incidents were reported in the northeast and West Coast—30 per cent of the total in each of these.

Nearly 75 per cent of all incidents occurred between 500 feet and 14,500 feet, with 3000 feet as the median. In this range, 62 per cent were VFR, 38 per cent IFR. Two-thirds of the IFR operations were in IFR weather.

Ten per cent occurred above 24,000 feet—20 per cent of these being reported by military aircraft flying VFR. Approximately the same

**Bob Harrison**




*"What other aircraft?"*

number of conflicts at high altitude occurred between air carrier and military flights and between two air carriers or two military aircraft. At high altitude, 66 per cent of the military reporters were in single engine jets.

Problem areas pointed out by the survey include the following:

The present traffic control system is unable to prevent near-collisions. Approximately 43 per cent of all reported incidents occurred to aircraft on IFR flight plans. Nearly one-third of these were in IFR weather. Reports from controllers list personnel error, excessive controller workload, facility coordination failure, and limited capabilities of equipment such as radar as contributing factors.

The type of operator involved includes all military and civil operations. Contributing factors are lack of familiarity with system procedures and limitations, failure to follow instructions or regulations, and mixture of IFR and VFR traffic.

Traffic is concentrated over VOR stations between 3000 and 8000 feet. VOR is the predominant method of navigation in VFR as well as IFR operations. Aircraft tend to converge over stations, with pilots watching instruments instead of outside traffic.

Recognizing the seriousness of the midair collision potential, FAA and several manufacturers have concentrated on three areas: Collision Avoidance Systems (CAS), Pilot Warning Instruments (PWI), and Conspicuity Enhancement.

The CAS is the most complex of these and presents many problems that remain to be solved. To be effective it would detect other aircraft, evaluate the collision hazard, and alert the pilot as to the proper escape maneuver. While it appears that it will be some time before an effective CAS that is lightweight and economical will be available, much of the spade work has been done and the system requirements have been established. Development of the hardware has been slow due to the extreme complexity of the problem. Basically, the system needs only to inform the pilot of an appropriate escape maneuver. It should alert him only when the time factor is such that action is necessary. The false alarm rate must be kept to a minimum. Still to be analyzed is the effect of escape maneuvers on the air traffic control system, particularly in the crowded terminal areas.

The PWI will alert the pilot as to other aircraft in his vicinity. It will then be up to him to evaluate the need for escape action and the appropriate maneuver. One of the problems is how much and what kind of information to furnish the pilot. The system should be somewhat discriminatory, for example warning of intruders only at the same altitude as the interrogating aircraft. It will not, however, evaluate the threat of collision. And it is limited in that it would be effective only in VFR weather. Still to be determined are display techniques. It has been established that a pilot can spot an intruder sooner if he knows the approximate altitude and bearing of the other aircraft. With this information an observer can detect other aircraft at three or four times the distance at which they can be seen by uninformed observers.

Simulation has been used extensively in the research program to define the requirements of both PWI and CAS. Other techniques include ground scanning and flight tests.

Conspicuity enhancement is another area of investigation. Again the problems are not as simple as they seem. Research indicates that aircraft can be more easily seen when they have dark (low reflectance) paint on the underside and light (high reflectance) paint on the upper side. Normally dark paint will stand out against a lighter sky and light colors will contrast with the darker earth and foliage. This is

## MIDAIR COLLISION (continued)

frequently negated when an airplane is flying over snow or undercast. The use of fluorescent paint is useful at short range, but apparently does little good at long range (beyond about three miles). Test findings make it doubtful that fluorescent paints will become mandatory because of their limited value in relation to their high cost. Repainting is necessary after 12 to 18 months and is extremely costly.

Paint patterns were also investigated and found to contribute little to conspicuity, although large lettering on aircraft probably makes them harder to see.

Other possibilities investigated included the position of lights on aircraft, flashing versus steady lights and combinations, color patterns of lights, the feasibility of using lights to indicate altitude, and smoke emission.

Research conducted by the Naval Ordnance Test Station (NOTS) at China Lake, Calif., indicates that a cooperative type of infra-red PWI would be effective as a detector. Self contained infra-red from engine heat radiation does not seem feasible since very little heat is given off by light aircraft engines. The cooperative system would include radiation from a rotating beacon or similar source. A cooperative IR-PWI is under development and first flights should have been conducted by now.

Most of the research that has been going on has been aimed at trying to understand the problem and establish requirements for equipment. Collision avoidance hardware is still some distance down the road, possibly five years or more. At present it appears that color and lighting schemes probably will be the best available in airborne collision prevention devices for quite a while. ★

# HEAD ON!

*"At this very instant I noticed a flash, or shadow . . ."*

**In clear sky, 25,000 feet over Texas,** three Air Force aircraft collided. Miraculously, the four pilots survived. Here are their stories.

F-102 Lead: "We received a left turn command. I acknowledged, turned to and reported 'steady on!' We were between 26,000 and 25,000. I checked my altimeter and heading. At this very instant I noticed a flash or shadow followed immediately by a severe jolt, then a severe rotation to the right. I did not know if I had been hit or had an explosion. My airplane was totally uncontrollable. I heard no transmissions. I initiated ejection procedures. The aircraft was corkscrewing violently to the right. It took me about three turns to eject the canopy. I lost my helmet. When the canopy blew my hand was jarred from the ejection seat and I counldn't replace it. There was blood in the cockpit that appeared to be flying through the air. During the next several seconds I received the impression that my seat would not eject. The aircraft went into a flat spin that appeared to be right side up alternating with upside down. At this time I became aware that my Firewel kit, that the pilot sits on and is installed in the seat well, had come out. I couldn't eject or get my hand on the trigger. I tried to crawl out. I got both hands on the left canopy rail and managed to hook my fingers over the left canopy rail. G forces were throwing me to the left of the cockpit. I unfastened my safety belt and still could not crawl out. I realized my left foot was trapped under the instrument panel. I attempted to pry it loose by grabbing my leg and tugging. I was ready to kiss that foot good-by anytime I could just get to that handle and get out of there. At this time I assumed I was going down in the aircraft. It's impossible to describe the violence of the maneuver. I can remember very vividly looking over the peak of the windscreen and over the pitot boom. This is probably when I incurred eye damage. I thought I was going in. This makes you fight a little harder. I made one more effort, found the right trigger, pulled and away I went. The man who developed the rocket catapult should be commended. When I pulled I was not in the seat. I actually felt the initial slow stage of acceleration and I felt it come up and before I could think I was out of the aircraft."

T-33 IP (front seat). "I saw some substance in front of the aircraft, more of a flash or what appeared to be silver objects. I didn't know whether it was two airplanes or one large airplane, but it completely filled the windscreen. It was almost simultaneous with the sight that the impact was felt. The aircraft was uncontrollable. I told the other pilot to bail out. He said, 'O.K.' and ejected. The rotation got progressively worse and tighter. I had trouble getting my hands on the levers, but finally got them and ejected. I don't know at what point I lost my helmet. I didn't realize it was gone until after the chute opened."

T-33 pilot (rear seat). "I was under the hood. I felt a hard jolt and what sounded to be a mild explosion. At the same time the aircraft started a left roll around the longitudinal axis. The IP said, 'Bail out!' I said, 'O.K.', pulling both handles. As the canopy left the aircraft the hood was blown back across the front of my body. I squeezed the trigger and felt myself leave from an inverted position. I was gyrating to such an extent that I was not aware of leaving the seat. Due to the gyrations I was afraid I might lose consciousness so pulled the 'D' ring. Opening shock was very mild. At some point my helmet and gloves were both jarred off. When the chute did open, eventually I was slowed down enough that the hood came off and floated away."

F-102 Wing. "I was jolted by a flash coming between our two aircraft and physical impact with what I knew immediately to be another aircraft. I saw debris flying off lead's fuselage and immediately he rolled into my aircraft. I pulled up sharply. I then found my controls quite unresponsive with a tendency to roll off into a wing. I wanted to roll over and see where lead was, but was afraid of getting into an uncontrollable position. I tried to call control and report the midair. I tried several channels with no contacts. I went to Guard and continued to broadcast Mayday and my position. I also went to Emergency Squawk. I saw my left wing was damaged and turned the fuel off on the left side. After checking all instruments for engine damage I checked the aircraft at low speeds down to 250 knots. I then oriented myself with the field and made a 360-degree turn for a straight in. I checked aircraft stability with the gear down and down to 170 knots. I felt that was the lowest safe speed, and continued my approach at 210 knots. I could not obtain clearance to land. A T-33 was on the right side of the runway. I took the left."

This accident was bound to happen. It's just as possible today. When two jets happen to be on a head-on collision course one of the greatest deficiencies of the "see and be seen" theory is exposed. The rate of closure was 1326 feet per second. This meant that detection had to be made at over three miles for even a possibility of avoidance. At anything less collision becomes inevitable.

There are other factors that make such accidents as this inevitable when aircrew members alone are responsible for avoidance. Consider such things as pilots momentary glancing at their instruments, (F-102 Lead: "I checked my altimeter and heading. At this very instant . . ."), windscreen obstructions, reduced visual acuity and other human factors that decrease the ability to detect aircraft at distances of three miles and beyond.

The conspicuity paint on the T-33 and collision lights are considered to have been of little aid in detection with the aircraft on a head-on collision course in daylight hours.

The narrow head-on profile of T-33 and F-102 aircraft makes it virtually impossible for pilots to detect such aircraft at more than three miles.

GCI, providing vectors to the '102s, didn't paint the T-33. (Skin paints of many aircraft, particularly light aircraft, are extremely difficult to pick up.) ★

# New FABRIC To Save Lives

*Capt. Clarence O. Little, Jr*
*Nonmetallic Materials Lab., ASD*

A NEW TEMPERATURE resistant organic fiber which will extend the useful range of such fibers to 550° Fahrenheit, and which will not melt, fuse or burn, is scheduled to be used in Air Force parachute packs by 1963.

Undergoing rigorous tests at the Aeronautical Systems Division, the fiber, called HT-1, should decrease the malfunction of parachutes after exposure to flames.

There have been instances where aircrew personnel have successfully escaped from burning aircraft only to die because their parachutes failed to function properly after exposure to flames or heat. Principal cause of these parachute failures lies in one of the inherent properties of nylon. When nylon is heated excessively or exposed to a direct flame, it will melt and fuse into a hard mass when cooled. Formation of these fused areas throughout the parachute pack or canopy causes the chute and pack to operate abnormally and fail completely.

Although this characteristic was recognized when nylon's use in parachutes was proposed, it was considered to be outweighed by the superior properties gained, such as high strength to low weight, mildew resistance and ease of fabrication and handling.

Because of Safety of Flight Unsatisfactory Reports from such parachute failures, a research project was begun. Object—develop a material to provide:

- A parachute pack which would prevent the penetration of heat and/or flames which would damage the canopy, pilot parachute, suspension lines and risers.
- A parachute which would be operational after a simulated aircraft fire averaging 1200° F for 10 to 12 seconds duration.
- A parachute which would hold to a minimum the effects of storage and rigging, and whose maintenance would also be at a minimum.
- Harness webbings capable of losing no more than 30 per cent of their rated strength after a simulated aircraft fire.

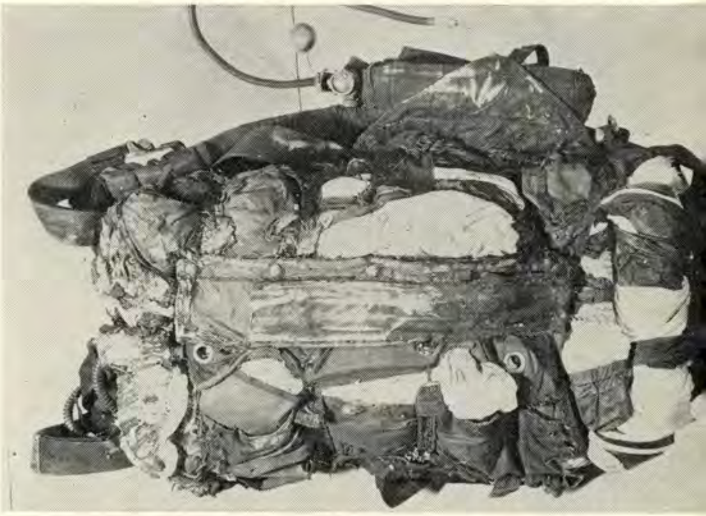
All candidate fibrous materials were subjected to various heat tests.

Since the parachute may encounter all three types of thermal energy, i.e., convection, conduction and radiation, the pack material had to be able to control all or any of these three types of thermal energy.

First phase of the research program to develop and evaluate a heat protective material followed several parallel approaches.

One made use of the knowledge that the most efficient reflector of radiant heat is aluminum. Use of commercially available aluminum coatings was thoroughly investigated by application methods, such as vacuum deposition, laminates and spray-on pigments.

A double layer of HT-1, with a sheet of aluminum foil sandwiched between, protected the canopy assembly in a simulated aircraft fire test. The outer layer burned off but the inner layer protected the canopy from excessive heat.



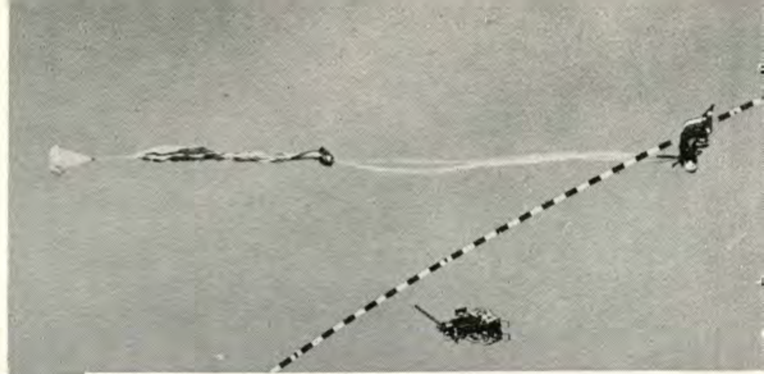
This parachute, which caused a pilot fatality, was exposed to fire during bailout by a crewmember. It did not open when the ripcord was pulled. The flaps were fused together, preventing the pilot chute from popping out. The parachute was repacked into a serviceable pack and drop-tested. It opened and made a normal descent, pulling apart the fused areas of the canopy.

This is the nylon parachute which was inside an HT-1 parachute pack burned during a test in aircraft fuel fire. The parachute was tested in a dummy drop and worked almost as if it had no holes.

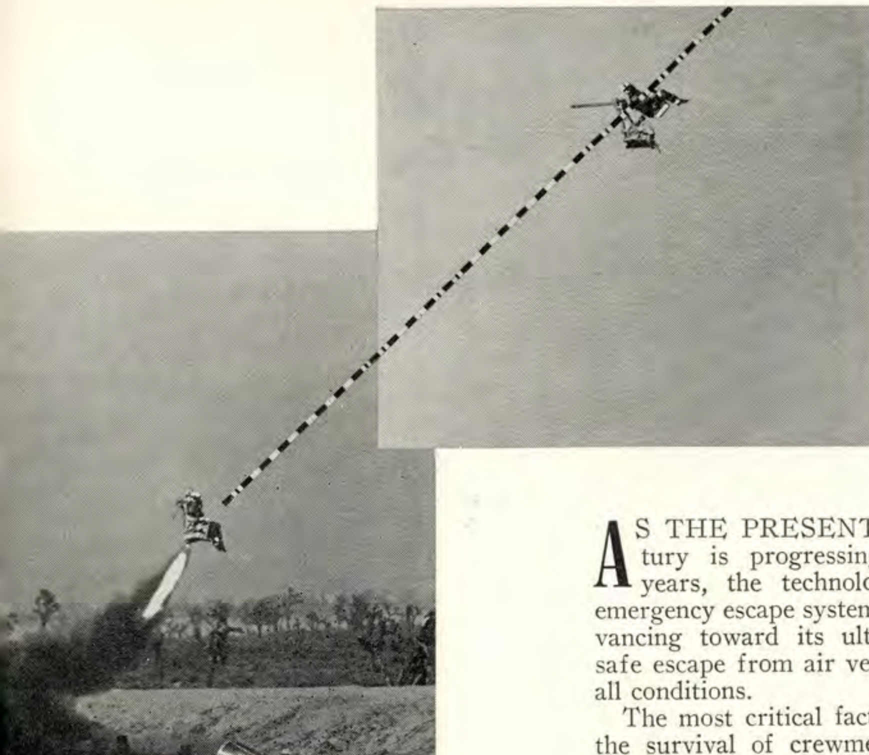
It was determined the double layer pack should be constructed to prevent the stitching from appearing on the outer surface of the pack because stitching destroys the integrity of the pack by allowing heat to penetrate into the canopy more readily.

This new fiber will soon be in production, and other ways of using the material to protect aircrews undoubtedly will be found. ★

*North American Aviation reports on an improved F-100 escape system . . .*



# ROCKET TO SUR



This scene depicts a dynamic sled test at Edwards Air Force Base Sled Track showing a dummy ejection with a North American Aviation ground level escape rocket-catapult seat. Two static and 11 dynamic sled tests were performed with peak ejected altitudes of up to 205 feet at speeds of 90 knots to 600 knots.

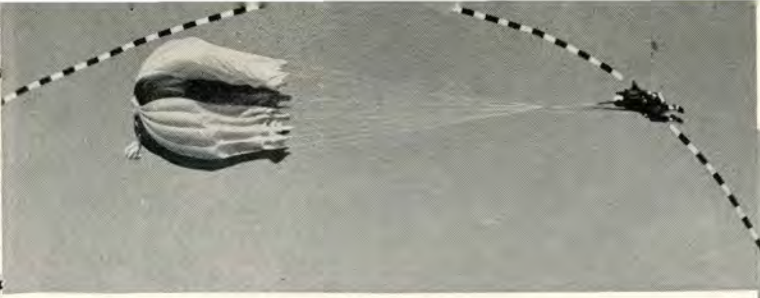
AS THE PRESENT 20th Century is progressing along in years, the technology of safe emergency escape systems is also advancing toward its ultimate goal: safe escape from air vehicles under all conditions.

The most critical factor affecting the survival of crewmembers during emergency ejection escape attempts is the amount of terrain clearance available at the time of ejection. The ultimate solution of this problem, zero altitude — zero airspeed escape capability, is not in the immediate future, however, significant advances in the technology of escape systems are being made. The development, qualification, testing and installation of rocket catapults and man-seat separators in existing pilot seats show great promise of a strong increase in crew survival probability during extreme low level ejections.

All series of the first century bird —the F-100—are scheduled for immediate retrofit with a ballistic rocket catapult. This new rocket powered ejection seat, together with the man-seat separator installed previously per TO IF-100-788, provides a safe escape capability of zero altitude at speeds of 120 knots and above. In addition, greater vertical stabilizer clearance is provided during high speed ejections. Rocket catapults are currently installed in the F-104, F-106, some F-102s, T-38 and B-58 airplanes.

The modification (TO IF-100-821) entails principally the replacement of the M5 catapult with a ballistic rocket catapult and adding several fittings to the lower aft corner of the seat to receive the forward rocket motor thrust load.

Pilot actuation of the rocket powered ejection seats on all the F-100 series airplanes will be identical to the existing system. On the two-place F-100F a sequencing system is required to eject the aft seat before the forward seat in order to assure that the rear pilot will not be subjected to the rocket blast from the front seat. A one-half second time delay initiator is used for this purpose. The pilot in the rear seat can eject himself only; however, the pilot in the forward seat can eject the pilot in the aft seat and then himself, one-half second later, through the automatic sequencing system. The ejection sequencing system contains all gas fired initiators and therefore requires no additional maintenance safety pins.



# VIVAL

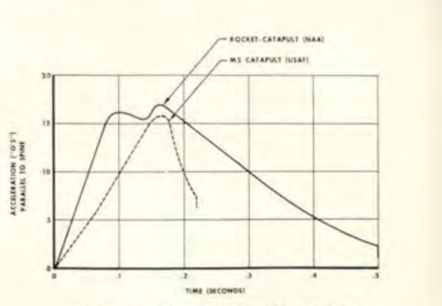
Precautions must be taken, during the installation of the new system, to insure the installation of the correct rocket catapult in the particular series of the F-100 airplanes (F-100A, F-100C, F-100D and F-100F). Also the rocket catapult must be oriented correctly in relation to the seat. This is necessary because the rocket motor, or stage II of the rocket catapult, must thrust forward and, because the angle of the center line of rocket thrust to the center line of the rocket catapult varies with the different F-100 series airplanes. A warning notice is engraved on the top of the rocket catapult at the seat attach point. This identifies which face of the rocket catapult should be installed forward and which model F-100 airplane each particular rocket catapult is used on. This warning is easily visible and should be carefully rechecked after the installation has been completed. Serious seat malfunctions will result if this warning is not adhered to.

Attitude control of the seat-man combination is dependent on the relationship between the center-line of rocket thrust and the center of gravity (CG) of the man-seat mass during ejection. This being the case, any additional factors which could adversely affect this situation should be avoided. An example would be a survival kit located in the back seat bottom which is over the thickness limit as spelled out in the flight manual. Be sure to check the proper flight manual on this, as the thickness allowed varies with different series of airplanes.

The *disconnect*. A disconnect is required to separate the initiating gas hose from the seat. Naturally, it is important that this item be connected or the system will not operate. To call attention to this fact a warning notice, "unit is not connected if red shows" is affixed to the disconnect. Disconnects are so located as to be readily accessible and visible for inspection and maintenance. During a crash emergency the disconnect should be disconnected by tripping the trip level located on the disconnect.

The disconnect bracket on the seat should be handled with care to prevent misalignment of the disconnect with the trigger bracket on the airplane. Any time the seat is removed for maintenance or a new seat is installed the tripper bracket on the aircraft should be checked in accordance with the TO to insure engagement of the tripper bracket with the tripper arm.

*Man-seat separator*. The F-100 series is also being modified (TO-IF-100-788) to provide a positive means of man-seat separation. An A-shaped webbing is used to automatically separate the pilot from the seat at the same time that the lap




COMPARISON OF MS CATAPULT AND NAA ROCKET-CATAPILT PERFORMANCE UNDER AVERAGE CONDITIONS

# ROCKET TO SURVIVAL

*(continued)*


Disconnect completely engaged.

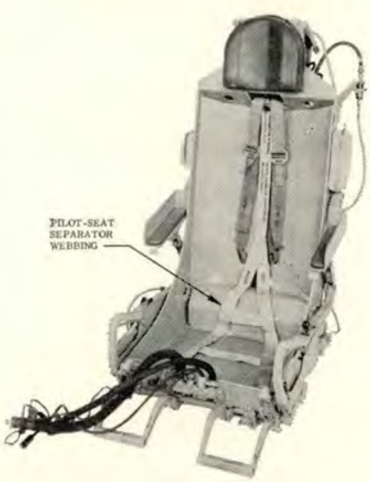
Disconnect not engaged

Disconnect partially engaged.

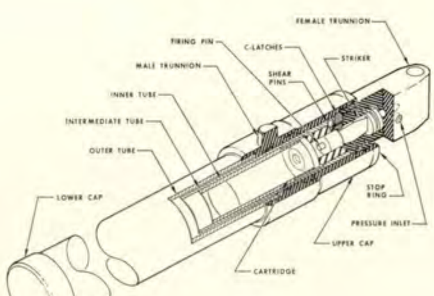
belt opens. The webbing lies on the bottom of the seat and extends up the back of the seat and over a roller under the headrest. The forward ends of the webbing are attached to the front of the seat and the rear is attached to a rotary actuator under the parachute shelf at the bottom rear of the seat. During operation the webbing is pulled taut, forcing the pilot from the seat. The webbing should never be routed over the top of the pilot's seat cushion or other equipment.

On the A and C model aircraft two separate filler blocks are installed in the back of the seat. These blocks were designed into the seat after the original design to allow for a reduction of two inches in the current parachute pack and a proper position of the pilot's eye level. Both blocks are necessary and the man-seat separator webbing was designed with blocks installed. The webbing is not the proper length with either of the blocks removed. ★

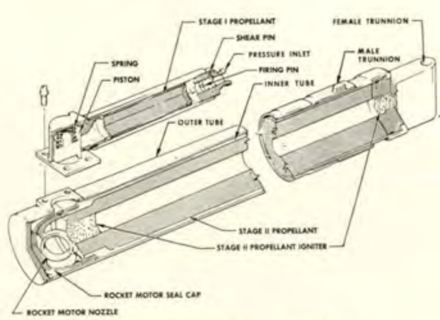
Pilot-Seat separator webbing shown in actuated position.


Pilot-Seat separator webbing shown in stowed position.




M-5




ROCKET CATAPULT

# Guillotine

*Lt Col H. M. Hegyessy Jr., Directorate of Missile Safety*

AN INCIDENT — reminiscent of the days of the French Revolution when the guillotine was the popular tool for disposing of unwanted nobility—has marred the missile safety picture for 1962. A bit of explanation is in order.

Before the advent of the GAM-77 Hound Dog Missile and its Mother-bird, the B-52 aircraft, a vast hangar was built at a SAC base to accommodate out-of-the-weather maintenance of a giant aluminum overcast known as the B-36. This hangar was so huge that it was determined, quite logically, that a means should be devised to prevent the automatic fire deluge system from inundating the whole structure and subsidiary activities in the event of a fire in a given local area in the hangar.

Again, man provided the answer. The decision was to suspend 2′ x 10′ corrugated metal sheets vertically from the roof to form flexible curtains or heat traps to channel the hot air from a fire on the hangar floor to a given local segment of the automatic fire sprinkler system. This would positively activate the deluge required to deal with the fire but leave the remainder of the hangar unscathed and reasonably dry.

The day of the B-36 passed. Another major command became the landlord of the base and the SAC wing, refurbished with B-52s, remained as a tenant. With the advent of the GAM-77 missile, maintenance space was needed for this new weapon. The host activity compartmented the hangar to a degree, retaining a portion of the space for its own aircraft maintenance. Although crowded and not quite ideal, this arrangement served for GAM-77 shop maintenance. The corrugated metal curtains remained suspended 80 feet in the air over unsuspecting missile maintenance men.

Time marched inexorably on. The daily, near-hurricane breezes that continued to afflict this garden spot brought with them a familiar companion, "Metal Fatigue." The fire curtain fasteners were not exempt.

One quiet evening, during a lull in maintenance activity in the GAM-77 shop, a lonely Hound Dog Missile with its nose cone removed stood patiently waiting for TCTO action. A gust of wind howled through the hangar door. With a sickening "snap" a sheet of corrugated fire curtain came slicing down like the blade of a gigantic guillotine. It cut part way through the exposed forward equipment beam of the Hound Dog with ridiculous ease, barely missing a tank of deadly, liquid, anhydrous ammonia, and richocheted viciously over an area normally occupied by latter-day "nobility" trained missilemen.

The U. S. Air Force was lucky that night. No one was hurt. The missile was repairable. The fire curtain could be refurbished. But it was a "near" miss. A note of irony exists in that a contract had been let only a few days before to retrofit the curtains.

In the never ending search for hazardous conditions which threaten the combat capability of the Missile Force, Missile Safety Officers should remember the lesson of the "Guillotine" in 1962 and survey "up" as well as in and around and under their charges to eliminate the potential dangers of the Aerospace Age. . . . ★

PILOTS OF THE F-104A AND B are now flying an aircraft with a new engine designed to be more reliable while also being easier to maintain. This engine, designated J-79-3B, is the result of Project HARDCORE, which produced some 18 major changes in the -3A model.

To get a feel for the new engine before it was flown in the field, Lt Colonel Daniel Hagarty, DIG/Safety F-104 project officer, flew a test evaluation at Edwards AFB along with General Electric test pilots. During his evaluation of the engine, he flew the 1000th hour on G. E.'s bailed test F-104, the first of the Starfighters to reach 1000 hours entirely in flight test status. This aircraft started its test career back in August 1957. It has seen duty in several projects and returned to the Flight Test Center at Edwards where it recently completed the 500-hour durability test on the -3B engine.

Of the engine test, Lt. Colonel Hagarty had this to


# ....... PROJECT

say: "One of the most thrilling experiences a young tiger can look forward to is strapping a 4 to his derriere and challenging the elements above old terra firma. There were times, I'll admit, when these engagements resulted in vibrations, deceleration, loud noises and balls of fire emitting from the old tail pipe. When this happened the hapless hero at the controls wished he was engaged in some less hazardous pastime —like bird watching.

"General Electric was no less concerned and many engineering studies were made resulting in changes of hardware. Extensive studies in all areas to increase the reliability of the J-79-3A resulted in Project HARDCORE. This project was far from grabbing straws and included a realistic effort to eliminate compressor stalls at critical phases of flight.

"The first HARDCORE engine has now successfully completed 500 hours of flight testing at the General Electric facility at Edwards AFB, California. The profile missions flown were equivalent to the requirements of operating units.

"I was grateful for the opportunity to participate in the evaluation of the -3B engine. From the start of HARDCORE, I have been thoroughly briefed by G. E. engineers on each of the mods and what each should do to increase the reliability of the engine. To fully understand all the parameters of redesign and installation of HARDCORE would require engineering degrees which I do not possess. Therefore, my impressions are strictly what I felt as a G. I. pilot.

"The engine operated smoothly from start to full AB, and not once did I find myself knee deep in adrenalin clutching madly for my eyeballs on the windshield. Throttle chops and bursts failed to produce even one little rumble. T-2 cutback appeared to come in a little early, but T-2 reset was right on schedule. I was really impressed with the coreburner as I attempted light offs at various altitudes. Not once did it fail to light, and on every flight I made repeated lights at 50,000 feet. Care must be taken not to advance the throttle too far into the AB range before light off as the ramp-cam is still there. The chances of AB light at altitude with wide open nozzle is like getting to stand in for Richard Burton. With the coreburner you still feel a slight bump somewhat like 'switch over' but not as rough or pronounced.

"All in all the engine appeared to be a great improvement over the -3A. I sincerely hope that the using agencies will have the same reliability I witnessed at Edwards."

Modifications included in the project were:

MAIN FUEL FILTER. A new high-capacity filter will provide more accessibility, longer life and positive indication of the need for cleaning the filter element.

• AFTERBURNER IGNITION SWITCH. A new electro-mechanical AB ignition switch will provide more reliable, positive action. There is also a new electrical harness.

• VARIABLE STATOR FEEDBACK SYSTEM. This system has been redesigned to provide a more reliable, durable feedback system requiring less maintenance.

• NOZZLE ACTUATOR SEALS. Provide improved sealing characteristics under all temperature conditions and prevent piston rod corrosion.

• WELDED FITTINGS FOR NOZZLE ACTUATORS will help eliminate leakage problems.

• FUEL AND OIL DRAINS. The -3A one-manifold drain system was divided into two drain systems. This will reduce the possibility of high-flow drainage pressurizing the common drain system and forcing fuel through component seals into gearboxes.

• COMBUSTION LINERS were redesigned to increase service life and reliability by reduction of distortion and cracking.

• TRANSITION DUCT replaced the annular transition liner. The duct is attached to the inner combustion casing just ahead of the first stage turbine nozzle.

• NOZZLE FEEDBACK SYSTEM has been modified to reduce internal friction resulting from the present routing and clamping.

• NOZZLE ACTUATOR PIN, for attaching the nozzle actuator to the bracket on the tailpipe, will be slightly longer to eliminate possible interference between washers under the head of the pin and cotter pin hole in the actuator pin.

• NOZZLE AREA CONTROL. The throttle system has been modified to reduce throttle cam wear by reducing the cam follower pressure angle and cam loading.

• MAIN FUEL NOZZLES will be changed in several ways to reduce entrapment of contaminants and to prevent clogging or collapsing of screens.

• NR 2 BEARING. Several changes were made to reduce aft loading on the bearing; to reduce oil leakage, larger 17th stage leakage ports were provided forward and aft of the Nr 2 sump area and seals and races were changed. Other mods will reduce failure of the retention bolts for the Nr 2 bearing.

• FIRST STAGE TURBINE NOZZLE improvements include strengthening of the inner-band forward flange, redesigned vanes, different material to reduce distortion of the outer aft flange and chamfering of the inner forward flange to provide adequate air flow.

• HONEYCOMB TURBINE SHROUDS are made of 10 honeycomb segments. Hastelloy-X alloy backing plates will be used for the first stage while Inconel alloy backing plates will be used in the second and third stages.

• NR 4 TAILPIPE-LINER DAM. The air seal on the rear duct will be relocated to alleviate premature crack-

# HARDCORE . . .

ing of Nr 4 liners and reduce the necessity for excessive maintenance.

• COREBURNER AFTERBURNER SYSTEM. The -3A sector system was replaced with the coreburner system. This will eliminate switch over, blowout and instability problems with their associated maintenance problems.

There is a new AB control that schedules fuel flow as a function of throttle angle and compressor discharge pressure and splits the total flow into core and anulus flows.

A new AB pressuring valve performs the function done by the -3A flow divider and selector valve.

Fuel manifolds and spraybars were modified to be consistent with the coreburner system.

Other improvements to the AB system include lengthened torch igniter strut that will facilitate AB ignition while on minimum reheat operation; a torch igniter nozzle that can be removed without removing the torch igniter assembly; a new torch igniter liner with a special adapter to receive the aerated fuel nozzle.

There is a modified turbine frame, a new sparkplug with a different lead, different method of retention and a changed firing tip to make it compatible with the coreburner system; the afterburner tailpipe assembly was modified so that it would accommodate the coreburner AB fuel system. A new AB fuel pump inlet valve of plug type replaces the former piston cup and piston type valve. Changes were also made to the torch igniter fuel filter to prevent reverse installation and eliminate external fuel leakage.

• A-286 STATOR VANES. To improve service life, stator vanes fabricated from A-286 alloy, a highly corrosion-resistant material, are being used in stages seven through 17.

Lt Colonel Daniel D. Hagarty
Tactical Br, Fighter Div.

• SPEED DERIVATIVE AMPLIFIER. The temperature amplifier will include a speed derivative function to eliminate exhaust nozzle fluctuations and to provide more uniform engine performance throughout the engine operating range.

• HEAD- AND ROD-END HYDRAULIC FILTERS. The 40-micron bidirectional filters will be installed in the nozzle hydraulic system. They will include an integral bypass feature to retain trapped contamination when the filter is in bypass. ★

**AIRCRAFT POWER PLANT RELIABILITY** is the theme for the 51st Air Force-Industry Conference scheduled for October 10-12, 1962, at Riverside, California. The purpose of the conference is to exchange ideas for improving safety features and eliminating engine problems. Approximately 500 representatives are expected to attend and discuss such subjects as:

***Impact of Engine Failures and Related Problems.*** Part I will be presented by MATS and Part II by TAC.

***Methods of increasing reliability*** of in-service engines at manufacturers facility, overhaul depot and wing. Part I will be presented by the Pratt & Whitney Division of United Aircraft Corporation, and Part II by General Electric Company.

***Fuel Control Deficiencies*** — Methods for improved quality control during overhaul and installations. Part I will be presented by Hamilton Standard and Part II by Woodward Governor Company.

***Fuel pump failures***—procedures to improve reliability. Part I by San Antonio Air Materiel Area, AFLC, and Part II by Pesco Products Division, Borg-Warner Corporation.

***Aircraft Jet Engine Maintenance.*** Part I by American Airlines, Inc., Part II by Continental Airlines, Inc.

***Monitoring and Detection*** of Impending Turbo Jet Engine Failures. Part I by Lockheed Aircraft Corporation, and Part II by General Dynamics/Fort Worth, General Dynamics Corporation.

***Quality Control*** During Engine Overhaul and Modification by Air Force Logistics Command. ★

# ☆ 1st Lieutenant DAVID R. VANCE

### *86 Bombardment Squadron, RAF Sculthorpe, England*

# WELL DONE

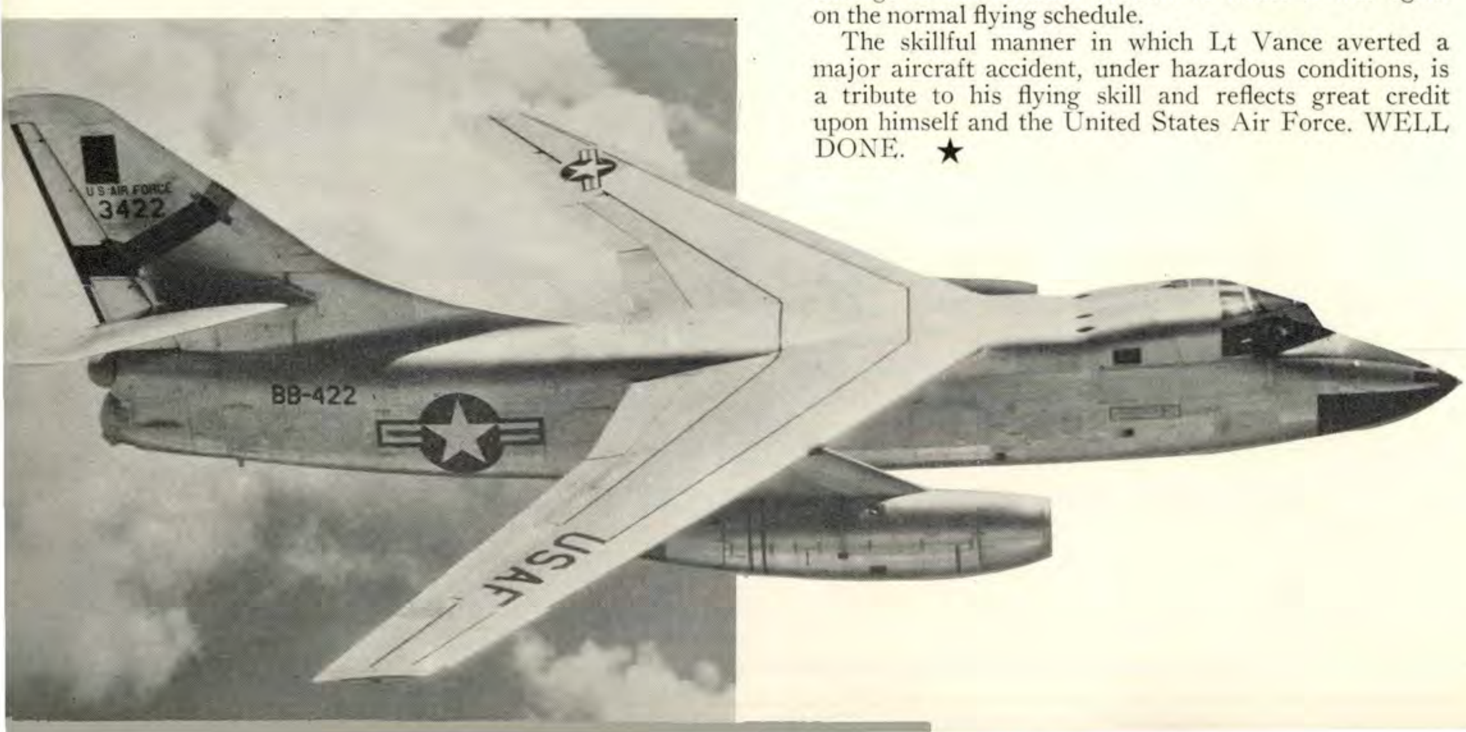
OUTSTANDING SKILL displayed in landing his crippled aircraft has earned 1st Lt David R. Vance, 86 Bomb Sq., RAF Sculthorpe, England, a WELL DONE award.

On 8 August 1961 Lt Vance and his crew took off in a B-66 on a training mission. Weather was 600 feet broken, 1.2 miles visibility, winds 130/13 with gusts to 19 kts. Immediately prior to liftoff the right wing dropped sharply, but the pilot was able to raise it with no difficulty and continued takeoff. Actually, the right main wheel had separated from the aircraft. Maintenance personnel observed the wheel leave the aircraft and the news was passed to Lt Vance through Air Traffic Control.

Lt Vance immediately flew to the Sculthorpe TVOR and established a holding pattern at maximum endurance airspeed. During the next three and a half hours the crew assessed the situation and decided on a gear down landing. On GCA final, however, visibility dropped to less than one mile in heavy rain. With the deteriorating weather, Lt Vance climbed out to rendezvous with a KB-50 tanker for emergency refueling in order to wait out the weather.

When the weather improved another attempt was made at landing. With fire and emergency equipment in place on the ground, Lt Vance landed the B-66 on the intact gear 500 feet down the runway. Immediately after touchdown the drag chute was deployed, left engine stopcocked and nose gear lowered to the runway. As flying speed was lost the right main gear brake assembly contacted the pavement and the aircraft veered sharply to the right. Skillfully using the remaining brake and nosewheel steering, Lt Vance maintained directional control almost in the center of the wet runway for 1500 feet. The aircraft then entered a gradual skidding turn and stopped 3000 feet from initial touchdown 90 degrees from the runway heading. There was no fire, no injuries and only minor damage to the aircraft. Within 48 hours it was again on the normal flying schedule.

The skillful manner in which Lt Vance averted a major aircraft accident, under hazardous conditions, is a tribute to his flying skill and reflects great credit upon himself and the United States Air Force. WELL DONE. ★



# TURMOIL IN THE TOWER

### . . . OR THE FOIBLE OF A NONUNION FACILITY.

*A 21 Minute Chronology*

Cast
(In order of their appearance)

| | | |
|---|---|---|
| CT | a frustrated controller | Charlie Tower |
| Gall 26 | a real picky pilot | Himself |
| TA | a very inquisitive airman | Transient Alert |
| AO | a zealous officer | Aerdrome Officer |
| Sam 4 | a cool, disinterested pilot | Himself |
| OPS D | an efficient middle man | Operations Dispatcher |
| Wx F | a victim of circumstance | Weather Forecaster |
| OPS 1 | a watchless hacky | Operations Vehicle |

PROLOGUE

Non-ATC functions, such as the maintenance of special traffic records for base purposes and relay of messages concerning transportation requests, refueling, or other miscellaneous information to various agencies at the airport are not the responsibility of an ATC facility. AFM 55-14

ACT I, SCENE I

The action takes place in the control tower at Charlie AFB. CT is the only character that makes an appearance. All other characters are represented by voices that are received on the many hot lines, radios and telephones located in the tower. CT is the tower supervisor. In the background, but not distinguishable, are a 5 level airman and an OJT airman. It is a normal swing shift.

TIME: 1912

CT: Gall 26, you're down at 12. Turn right at the intersection and stand by for the Follow Me.

Gall 26: Roger.

*TA: Hey, Charlie, would you ask Gall 26 if he's going to RON?

*CT: Rog. (CT is about to call Gall 26 when the Ops line rings. He answers.) CT.

*AO: Would you ask Gall 26 if he's going to RON?

*CT: Yes, sir. (Picks up mike.) Gall 26, are you going to RON?

*Gall 26: Affirmative, Tower, and I'd like to park this bird in the hangar.

*CT: Stand by. (Calls AO.) Sir, he's going to RON and wants to park in the hangar. (Call TA.) He's going to RON and wants to park in the hangar.

*TA: He says he wants to park in the hangar? HE WANTS TO PARK IN THE HANGAR! WU-ELL! We don't have any hangar space. Take him out to Boondock 3.

CT: Roger. (Picks up mike.) Gall 26, CT. Upon reaching the North ramp, turn right and follow Alert for parking.

*Gall 26: Where are they going to take me? Are there any tie-downs available? Do they know I want to park in the hangar?

*CT: They're taking you out to Boondock 3 and TA has been advised of your request.

*AO: CT, this is the AO in the Ops 1 vehicle. Where are they taking Gall 26? Does the aircraft have hazardous cargo? Why is TA parking the aircraft out there?

*CT: TA is taking him out to Boondock 3.

*AO: Well, tell TA to park him in front of Hangar 2.

*CT: Roger. (Calls TA.) TA, the AO says to park Gall 26 in front of Hangar 2.

*TA: (Resignedly.) OK. Would you ask Gall 26 what time he's going to take off in the morning?

*CT: You'll have to ask the pilot that yourself.

Curtain

SCENE II

Same as Scene I. The time is the same. Sam 4, a diverted VIP aircraft, is in contact with CT. The scene opens during the last of the radio contacts between Sam 4 and CT.

CT: Roger, Sam 4, when over the Charlie beacon, contact Charlie Radar on channel 17, frequency 335.8.

Sam 4: Roger.

*Ops D: Request the name, service and transportation requests of the VIP.

*CT: Roger, I'll get it as soon as I can. (There is a pause of several seconds during which time CT is trying to get the requested information from Charlie Radar who now has control of Sam 4.)

*Ops D: (Irritably.) CT, request the name, service and transportation request of the VIP immediately.

*CT: Roger, as soon as I can.

*AO: CT, request you inform me of the whereabouts of the VIP at all times.

*Ops D: Let me know as soon as the aircraft touches down.

Wx F: Ask the pilot for a report on the bases.

*TA: Ask the pilot what side of the aircraft his door is on and if he's going to RON.

*Ops D: Tell Ops 1 to return here immediately.

*Ops 1: By the way, Charlie, what's the correct local time?

1933 hrs: Sam 4 landed.

Curtain

*Denotes Non-ATC functions.

EPILOGUE

The original play had six additional characters, namely: 2 VFR T-Birds, 2 IFR Departures, the Center and an adjacent tower. However, the producer insisted that these roles be cut since they didn't add any real significance to the play. ★

*Maj. Roger B. Condit, Jr., AFCS, Chanute AFB, Ill.*

# IFR REFRESHER

THIS SHORT ARTICLE won't make you the world's greatest instrument pilot, but if you don't pick up a few pointers on everyday instrument flying, you are already well above average. It deals strictly with fundamentals that you can expect to encounter anytime you file an IFR clearance. These are the basic procedures most often needed, and frequently not understood — procedures that instructor pilots continually must explain. Most of these procedures can be found in AFM 51-37, AFR 60-16, Enroute Supplements, and other publications in considerably more detail.

FILING THE CLEARANCE. The first block of Section C of the DD 175 "Radio Call" is where the aircraft call sign is to be entered, followed by the slash and an appropriate symbol as follows:

Transponder without code /X

Transponder with code (SIF) /T

DME /D

DME and transponder without code /L

DME and transponder with code /B

The first line under "Route To Be Flown" must list the SID. If a Radar Vectored Climb is requested in the "Remarks" section, the SID must still be shown. An alternate is required when there is not:

A ceiling of at least 5000 feet and a prevailing visibility of at least five miles are reported at the destination or point of IFR termination and are forecast to remain from the time of the latest report until one hour after ETA.

SETTING THE ALTIMETER

The altimeter should always be set at field elevation, making allowance for the aircraft's location on the field as most fields are not level. The Kollsman window reading should then be compared with the altimeter setting. Add or subtract this difference and apply it to all altimeter settings on the flight. If the difference causes an indicated altitude error of over 75 feet the altimeter is not within allowable limits and should be written up in part 2 of the Form 781. In flight, whenever the aircraft proceeds into an area of lower pressure or lower temperature, actual altitude will be less than indicated altitude. In reading the altimeter, read the long thin hand with the triangle on the end (10,000-foot hand) then the short hand (1000-foot hand) then the large hand (100-foot hand). The stripped area is visible only below 16,000 feet.

TAKEOFF MINIMUMS. No less than published landing minimums unless established otherwise by the pilots' major air command. Obviously the facility on which minimums are based must be operational.

LEVEL OFF. Allow a lead equal to 10 per cent of the vertical velocity and level off on altitude. You were cleared to 10,000 feet, not 10,200 then back down.

SCANNING or CROSS-CHECKING. A good rule of thumb is to scan the attitude indicator between scans of any other instrument or instruments. For any change of attitude, first set the desired change on the attitude indicator, then make adjustments as necessary by cross-checking performance and navigation instruments.

TURNING. Pre-determine the amount of bank then roll in to that degree of bank. Lead roll out by 1/3 the number of degrees of bank and roll out at the same rate that was used for roll in. Once rate of roll out is known this figure should be used

PROCEDURE TURNS. If within 45 degrees of the reciprocal of the final approach course, fly a teardrop on the maneuvering side. If airspeed is below 180 knots TAS, fly a 20-degree teardrop for two minutes. If airspeed is above 180 knots TAS, fly a 30-degree teardrop for 1½ minutes. Correct for wind drift in either case. Do not begin descent from procedure turn altitude until within 20 degrees of the inbound course. (Figure 1.)

If more than 45 degrees from the reciprocal of the final approach course, turn the shortest direction to the reciprocal heading and proceed outbound. Start time and descent when wings are level. Below 180 knots TAS fly two minutes.

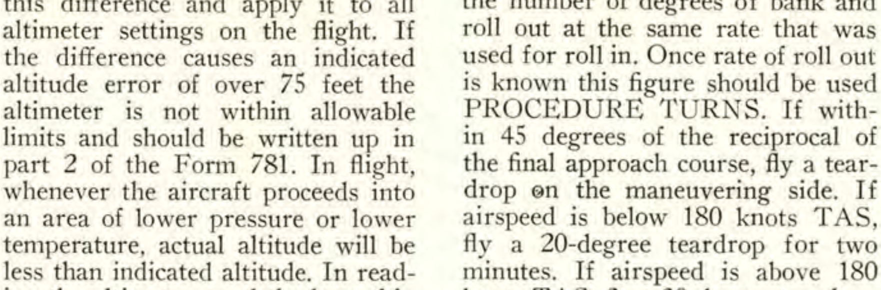



Fig. One

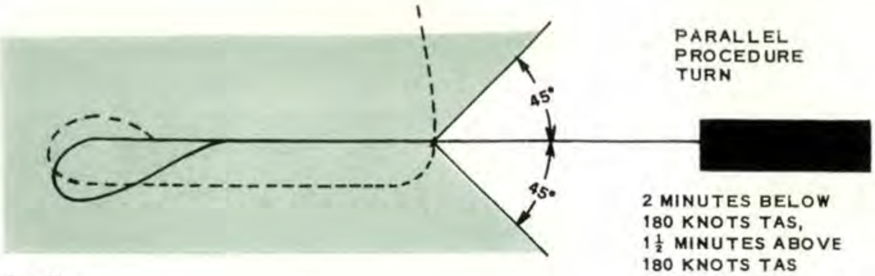



Fig. Two

Above 180 knots fly 1½ minutes. At the end of time turn toward the inbound final approach course, more or less than 180 degrees as necesary to establish an intercept angle. Again, descent to low station altitude may be started when within 20 degrees of the inbound course. (Fig. 2.)

(The 90-degree/270-degree procedure turn is still permissible but not preferred.)

UNUSUAL POSITIONS.

If you are diving, reduce power and roll to a wings level, upright attitude. Correct to a level flight indication on the attitude indicator and resume normal cross-check.

If you are climbing, add full power and roll to bring the bank index pointer to the nearest 90-degree index mark.

As the horizon bar and the dot of the miniature aircraft come together, establish a wings level, slightly nose low indication.

COURSE INTERCEPTION.

OMNI and TACAN (Inbound)

1. Set the desired course in the window with the ambiguity showing "TO."

2. Locate desired course on compass card.

3. Proceed along compass card to the head of the bearing indicator.

4. Turn to a heading 30 degrees beyond the bearing indicator. (Fig. 3.)

5. Complete course interception, using the Course Deviation Indicator.

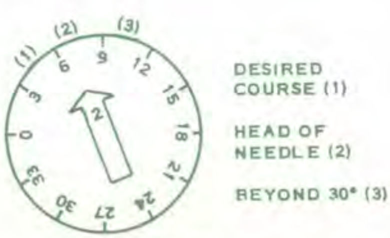



Fig. Three

ADF (Inbound)

Same as VOR except omit step one and step five.

OMNI and TACAN (Outbound).

1. Set desired course in the window.

2. Note the bearing under tail of bearing indicator.

3. Proceed along compass card to desired bearing. (Fig. 4.)

4. Turn to a heading 45 degrees beyond the desired bearing.

5. Complete course interception, using the Course Deviation Indicator.

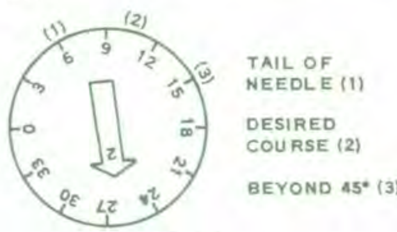



Fig. Four

ADF (Outbound).

Same as OMNI and TACAN except omit step one.

COURSE FOLLOWING (Inbound). If the needle moves left, turn left to a heading sufficiently beyond the needle to effect an intercept angle. If the needle moves right, turn right to effect intercept.

With VOR or TACAN and the desired course set in the window the CDI is directional and should be used as the primary course reference instrument. When the CDI is not fully displaced, the aircraft is within 10 degrees of course. (Each horizontal dot represents five degrees.) Always track on the closest station forming the route segment unless a radio changeover point is shown.

STATION PASSAGE.

ADF—When needle swings from nose to tail.

VOR—When TO replaces FROM in the window.

TACAN—When the range indicator stops decreasing.

HOLDING PATTERN ENTRY. When approaching the fix within 10 degrees either side of the reciprocal to the inbound course, fly a teardrop on the holding side. (Fig. 5.)

Fig. Five

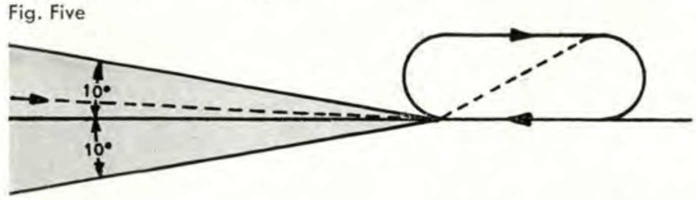
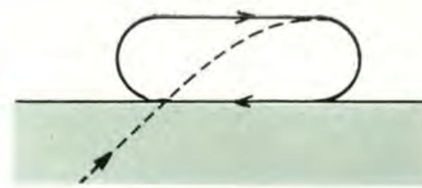


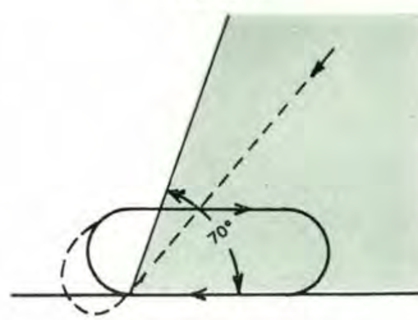

Fig. Six



When approaching from the non-holding side, turn outbound on the holding side. (Fig 6.)

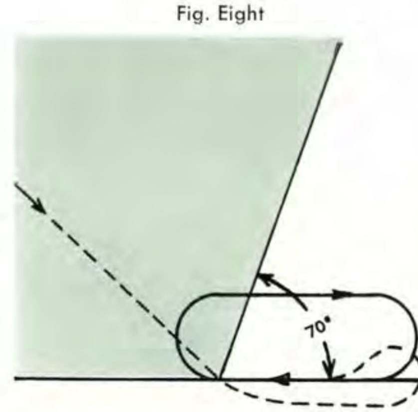
When approaching from the holding side and within 70 degrees of the inbound course, turn outbound in the holding pattern. (Fig. 7.)

Fig. Seven




When approaching from the hold-

Fig. Eight



ing side and *more than* 70 degrees from the inbound course, turn outbound on the non-holding side. (Fig. 8.)

When holding at or below 14,000 feet, fly a one-minute pattern. When holding above 14,000 feet, fly a 1½ minute pattern.

GCA. This comparatively simple approach system requires the pilot to follow directions of the Radar Controller. Never bank more than the number of degrees to be turned —standard rate turns maximum. If not contact at minimums execute the missed approach procedure as previously instructed by the controller. The pilot may or may not be advised when passing through minimums.

ILS. Position the aircraft inbound on the localizer course in accordance with terminal chart instructions. Establish final approach speed and landing configuration prior to intercepting the glideslope. Maintain glideslope interception altitude until intercepting glideslope. Check glideslope interception altitude at glideslope interception as a check of accuracy of the aircraft altimeter. When the CDI shows less than a full scale deflection, the aircraft is within 2½ degrees of the localizer course (each horizontal dot is within 1¼ degrees). Glideslope beams average one degree in depth, therefore, if there is less than a full scale deflection on the glideslope indicator, the aircraft is within ½ degree of the glideslope. Deviation indications occur more rapidly as the runway is approached. Small, immediate corrections are increasingly more important. At published minimums a missed approach is mandatory if weather is observed to be below such minimums.

When flying back course ILS (only authorized if published) the CDI is non-directional and there is no glideslope.

AIRWAYS FLYING.

Fly the centerline.

Report at all mandatory fixes.

Low altitude airways extend from the surface to 14,000 feet.

Intermediate altitude airways extend from 14,500 to, but not including 24,000 feet.

High altitude airways extend upward from 24,000 feet.

VOICE REPORTS. All altitudes through 9000 are reported in thousands and hundreds, e.g., 4500 is four thousand five hundred; 9000 is nine thousand.

All altitudes at 10,000 and above are reported by transmitting the first two digits independently, e.g., 10,000 is one zero thousand; 12,500 is one two thousand five hundred.

Monitor does not mean call—it means listen.

Mandatory Reports are:

- Position reports over compulsory reporting points, or points named in clearance.
- When ETA over reporting point changes more than three minutes.
- Before changing airspeed by plus or minus 10 knots from flight plan airspeed.
- To obtain a change of flight plan.
- When directed to report by ATC.
- When unexpected or unusual flight conditions are encountered.
- Time and altitude/flight level of reaching a fix or point to which cleared.

# • THREE MILES

THE AIR FORCE lost a fighter pilot last night. The last heartbeat was cut off when his body plummetted into the flat land of Central Texas. He hit 30 yards from the spot where his supersonic fighter disintegrated. The end came with a heavy bounce in a small oval of dust.

But the door to eternity opened 13 seconds before. It was the only door. When he saw 20,000 feet on his altimeter he made his move. He was one second too late. He thought he was almost four miles above Texas. He was three miles away, actually a little less.

He had been eight mile up when trouble started. The mission, a routine intercept on a SAC B-52. He had locked on and started his simulated firing pass. Without warning his fighter rolled inverted. First he tried to overpower the autopilot. No effect. He switched it off. Still no control. Something in the complicated electronic gear had fouled his control system. He tried the trim, then autopilot on and off. The maneuver wasn't violent. He sensed the increased speed and caught the Mach needle approaching one. Indicated airspeed was climbing toward 300. He interpreted the position of the instrument airplane as it was superimposed against the artificial horizon. Almost vertical. He pulled on the stick with both hands and ran the trim button to full up elevator. He could feel the buffet now, as the air protested the increasing acceleration. Altitude 30,000. The long hundred foot hand was spinning rapidly around the face. He pulled the power all the way off and fought with the controls again. In one infinitesimal flash of time he realized his mouth had turned to parchment. A decision was forming. The factors bearing on his decision never became identifiable: 20,000 feet was the turning point, the magic number that came vividly to him. If still no control at 20,000 he would go. Airspeed was over 400 knots now. One more glance; vertical now. He glued his eyes on the spinning altimeter and pulled on the stick with all his strength. As the hands hit 20,000 he started his ejection sequence . . . one second too late!

The altimeter in his Mach 2 Century Series fighter operated on the same principle as the one that had been used in F-86s in Korea, P-51s in WW II and Spads in WW I. All operate on differential pressure. Deflections of an aneroid are measured by hands on a graduated instrument face.

One of the faults of these instruments is lag. During climb and descent the instrument will indicate an altitude behind that of the aircraft; proportional somewhat to the speed of ascent or descent. Lag was of little consequence in aircraft of WW I vintage, and poses no problem for normal aircraft operations in good weather. But this night, in the fighter plunging straight down toward Texas, lag amounted to almost one mile.

Ten thousand feet is the Air Force minimum for ejection from an uncontrolled aircraft. The pilot knew this. He thought he had 10,000 feet, nearly two miles, to get out by the minimum. Lag robbed him of nearly half of this. Pressure altitude took another 400 feet. Above flight level 24,000 all aircraft operate on a

**Major T. J. Slaybaugh**

• When executing a missed approach.

• When vacating any previously assigned altitude/flight level.

• Prior to making an altitude change when VFR on top above 24,000.

• When leaving final approach fix inbound.

• When leaving an assigned frequency, unless instructed to change frequency by ATC.

• When leaving an assigned holding fix, or point.

In addition, on IFR direct flights, position reports are required as follows:

• High Altitude—at least every 300 miles.

• Intermediate Altitude—At least every 156 miles.

• Low Altitude—At least every 200 miles.

CANCELLING IFR.

Day—When pilot can remain VFR for the remainder of the flight.

Night—When the terminal airfield is reporting VFR and is in sight. ★

# FROM TEXAS •

standard altimeter setting—29.92 inches of mercury. At this point in Texas the actual altimeter setting was 29.52. The aircraft, while at this point in its flight, was actually 400 feet closer to the ground than its altimeter showed. At 20,000 feet the outside air temperature was minus 28 degrees—three degrees below standard. This too, caused the aircraft altimeter to read higher than actual altitude. Not much, but it took part of that one second the pilot needed. Another little chunk of the margin between a successful ejection and eternity was cut away by allowable altimeter error. This can be as much as 75 feet, plus or minus, on the ground. The pilot has no way of calibrating this error in flight. This robbed him of 120 feet.

At 20,000 feet indicated he was actually just under 15,000 feet. Now he was moving at nearly 500 knots, over 10 miles a minute, approximately 1000 feet per second; faster than a .45 caliber bullet. This two million dollar fighter was going to explode on impact in exactly 13 seconds.

The pilot, his decision made, reacted immediately as the altimeter went through 20,000. But what had to be done had to be done in sequence, and it all took time. He pulled his feet back against the seat and jammed his heels into the stirrups. His hands released the stick, his arms pulled them back and he wrapped his fingers around the grips on the seat. Thought and instinct meshed as he automatically went through the sequence he had practiced many times. He pulled up an arm rest and heard the sudden, high scream of the wind as the canopy blew. He pulled the other arm rest, then squeezed the trigger and felt the jolt as the seat fired.

The man-seat separator and automatic lap belt worked as designed. His body began to decelerate from 600 knots to terminal velocity of 125 knots. In the one second he needed he would have fallen 1000 feet, slightly less actually, because of the deceleration.

In spite of all the errors he might have made it. There was just one more card; it too stacked against him. Ground elevation in this Central Texas wheat field was 1138 feet. The 138 might have been enough. The seat had separated. The automatic lap belt had fired. The chute had started to deploy.

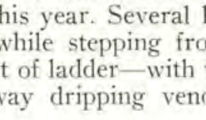
One more second, with its 1000 feet, would have been enough. It would have meant the difference. Just one more second, up there, three miles from Texas. ★

# AEROBITS

THAT OL' CHESTNUT, often quoted for a chuckle, is here again sculptured upon the rolls for posterity: "I pushed the gear warning horn button because tower transmissions were being blocked." I've heard this story for 20 years and each time I laughed politely, but inwardly there was doubt. Now it is recorded for all to see—on an official document. Here is truth!

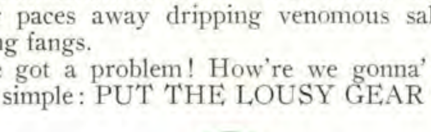
Now—same subject on different slant—who will quote odds on landing a dual manned airplane gear up? Jocks, before you put your moola on the blanket you'd better listen. A number of AF jocks have been chagrined so far this year. Several have wished they'd never been born while stepping from cockpit to runway without benefit of ladder—with the Ol' Man standing four paces away dripping venomous saliva from projecting fangs.

We've got a problem! How're we gonna' whip it? Quite simple: PUT THE LOUSY GEAR DOWN!



SECURE THE SNAP RETAINER—Information indicates that some organizations are stitching the open coil of the zero second deployment lanyard snap retainer to the chute harness. This is in direct violation of instructions in T.O. 14D1-2-554 dated 13 December 1959.

While it is not likely that this condition would actually prevent seat separation in the event of ejection, with the lanyard stowed it could result in a momentary delay. Any delay in effecting seat separation, regardless of duration, is extremely critical during low level ejection. Therefore, it is recommended that all organizations check parachutes in their inventory to make certain the snap retainer is secured in accordance with T.O. 14D1-2-554, 13 Dec 59.



HE HAD TO GROUNDLOOP? The investigation board findings stated: "The pilot failed to realize that the existing conditions precluded a successful landing."

After approximately five hours of flight, the C-54 arrived over its destination—a civilian airfield with a 5000-foot runway. The approach end of the runway was 36 feet higher than the opposite end, and no overrun. The weather reported was 1300 feet overcast with 1½ miles visibility in thundershowers. The aircraft touched down approximately 1000 feet from the approach end with higher than charted airspeed for its actual weight. It was necessary for the pilot to groundloop the aircraft to keep from going off the end of the runway. The landing gear folded, and substantial damage resulted.

For a landing on wet concrete, a roll of 4550 feet could be expected, using optimum braking technique. The minimum runway required under existing weather conditions was 5215 feet. Two additional factors to hinder the pilot's chances for a successful landing were (1) unpublished data about the downhill slope of the runway, and (2) wet asphalt has less friction adhesion than wet concrete. Pilot technique, weather, plus the condition and length of the runway can all be considered as major factors in this accident.

WHAT EMERGENCY? Fuel was normal after the deuce pilot completed his third low-level attack but shortly thereafter the bottom fell out. The aircraft climbed to 17,000 feet and headed for home about 80 miles away. Fuel state at this time was given as 2000 pounds. Seven minutes later he called minimum fuel and requested the nearest base. There was a base close by and GCI gave him a vector calling out the base at 35 miles. At this time he announced that his fuel was 900 pounds. The intercept director continued to give vectors down to eight miles but received no answer. The pilot had attempted a landing at a nearby small municipal airport on a 4000-foot runway, flamed out, hit short, wiped out the gear and the aircraft caught on fire. *Scratch One '102.* The pilot was lucky and received no injuries. Well, that's the way it goes—or is it? Let's back up a bit and run this one by again.

The first malfunction noted was that the speed brakes failed to operate during the initial descent for the second intercept. The condition was corrected when the pilot reset the circuit breaker. (Keep this in mind, it figures in later on.) On the third intercept the pilot had requested that the director turn the target, stating that he had to be getting home soon. The director turned the target, but not back toward home base. As it later turned out, IF the director had turned the target 180 degrees, the interceptor would have made it home in spite of the high fuel consumption; however, since fuel apparently was not a problem at this time the 180 was not made.

So, we press on. The first positive indication of an impending emergency was when the pilot called stating that he would have minimum fuel upon landing. At this time the pilot was cruising at 17,000 feet, 55 miles from the nearest base and 71 miles from home.

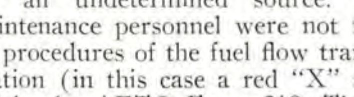
Although the pilot felt that he was in an emergency he did not switch to guard channel or to emergency SIF code nor did the director suggest that he do so. Use of emergency frequencies would have alerted the base GCA to stand by to assist. *Failure to do so was another step toward disaster.* With 800 pounds of fuel left and 25 miles from the nearest base, the pilot declared an emergency but did not go to guard channel or emergency squawk. In fact he wasn't even monitoring guard.

*We continue on.* The pilot was looking into the morning sun and visibility was not too great. About this time he sights a field ahead at five miles and assumes it is the base. (GCA at the air base was monitoring the transmissions—was not painting the aircraft—and did not mention this.) He went to tower frequency, set up an SFO, called turning base, and touched down 1/3 of the way down a 12,000-foot long

Air Force runway. Just like the book says, right? NO! He touched down one third of the way down a 6000-foot runway sans barrier at a nearby municipal airport by mistake. But no sweat, right? You can still probably stop that deuce with drag chute, maximum braking, etc. BUT—remember that little old speed brake malfunction at the start? That's right—the speed brakes did not open; the drag chute did not drag; the pilot did not rotate the drag chute handle 90 degrees for emergency drag chute deployment. The aircraft did not stop. SO—he runs off the end of the runway? NO! *He goes around with about 300 pounds.* Maybe he could have made it with a 90/270 degree reversal but he does not do this. He looks for a place to eject but the area is too well populated. So he comes around and attempts a landing on the cross-runway (less than 4000 feet), flames out, hits short, shears the gear, and slides to a screeching stop on fire. NOW Scratch One '102. Interesting? Yes. Avoidable???

C-124 MINOR ACCIDENT. Maintenance personnel were accomplishing a fuel system pressure check at the completion of a postflight inspection. Inspection had progressed to pressure check of fuel system components on No. 4 engine and at this point a maintenance technician indicated fuel vapor and visual fuel at the No. 4 engine position. The airman in the cockpit was instructed by interphone to turn off the fuel booster pumps, auxiliary power plant, and to evacute the aircraft. Within seconds, personnel outside the aircraft observed a fire. An explosion followed.

The primary cause of this accident was maintenance error: personnel failed to connect the heater fuel line to the fuel flow transmitter and when fuel pressure was applied to the system, the open fuel line on the fuel flow transmitter discharged raw fuel into the engine accessory section. The fuel/air mixture was ignited by an undetermined source. Contributing causes: maintenance personnel were not familiar with installation procedures of the fuel flow transmitter, and proper notation (in this case a red "X" symbol) was not entered in the AFTO Form 210. This negligence cost the Air Force the loss of one C-124 for more than 45 days, and 320 manhours in repair of damage to this aircraft.



MOUNTAIN CRASH. Wreckage of the twin-engine transport was discovered on a mountain peak 50 miles north of a VOR reporting point at the 12,000-foot level. The mountain peak is over 13,000 feet and is 24 miles east of the airway centerline.

The IFR minimum altitude for the entire route to be flown was 12,000 feet. The next checkpoint was estimated in 25 minutes when the last position report was received. The pilot was briefed on the latest weather over the last reporting point: winds 260 degrees at 40 knots, top of overcast 17,000 feet. The radial to be flown from the last reporting point was 314 degrees and the radial outbound from the next reporting point was 350 degrees. The crash site was approximately 350 degrees from the last reporting point. Adverse winds and a possibility of flying the wrong radial may have contributed to this accident, since no aircraft malfunction was detected.

ICE ACCELERATED STALL. Ice was picked up during climbout, however it soon disappeared after breakout on top at 10,000. The round-robin was continued as flight planned. Ice was picked up again during the instrument approach. Accumulations on the windshield partially reduced vision. At breakout below the overcast, glide path was high and to the right. Power was cut and an "S" maneuver made for runway alignment. The T-Bird stalled and, even at full open throttle, struck the PSP 800 feet short of the runway. Initial impact was on the right tiptank. The gear collapsed and runout was made on the left tiptank, wing and fuselage.

Two recommendations were an improved wind screen anti-ice system and a Dash One change to reflect: "During conditions of structural icing, maintain added final approach airspeed until at or near touchdown."

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T-BIRD TAKEOFF TRIPPED. Two T-33s made a formation takeoff over a BAK-6 cable. They crossed the cable at 30 to 40 knots and the right gear fairing door was torn from the No. 2 aircraft. The parent command has directed no formation takeoffs from airfields where the takeoff roll is over a BAK-6 or BAK-9 barrier.

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HEAVY FUEL STATE has been a factor in six major T-Bird accidents in slightly over six months. Pilots did not use jettison system. Statistics disclose that in 242 cases of intentional jettisoning, there have been but five instances in which only one tank jettisoned. This low malfunctioning rate of two per cent indicates that by far the safer procedure is to jettison rather than attempt heavy fuel state landings.

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NICKEL CADMIUM BATTERIES. Four major accidents associated with electrical difficulty point up the requirement of having adequate equipment to insure proper maintenance of these batteries. In one case locally purchased distilled water was suspected of being tap water. It is recommended that distilled or demineralized water be secured from a reliable source. Corrosion has been found between washers on individual cell terminal posts and between the washers and the plastic cell case. This is not always visible until the retaining spring clip and washer and/or nuts are removed. Adequate periodic inspection for such corrosion is mandatory. Action is being taken to provide spare nuts, washers and clips for replacement items and to effect a tech order revision to provide for identification of corroded items. ★

# WHAT IS C·A·T??

*This is another in the series of articles on Clear Air Turbulence. It includes a brief review, a status report on the CAT project, an indication of reliability of CAT forecasts and suggestions on reporting turbulence. If you fly above 16,000 feet or in any way deal with meteorology, it's pertinent.*

**William C. Huyler, Hq *Air Weather Service***

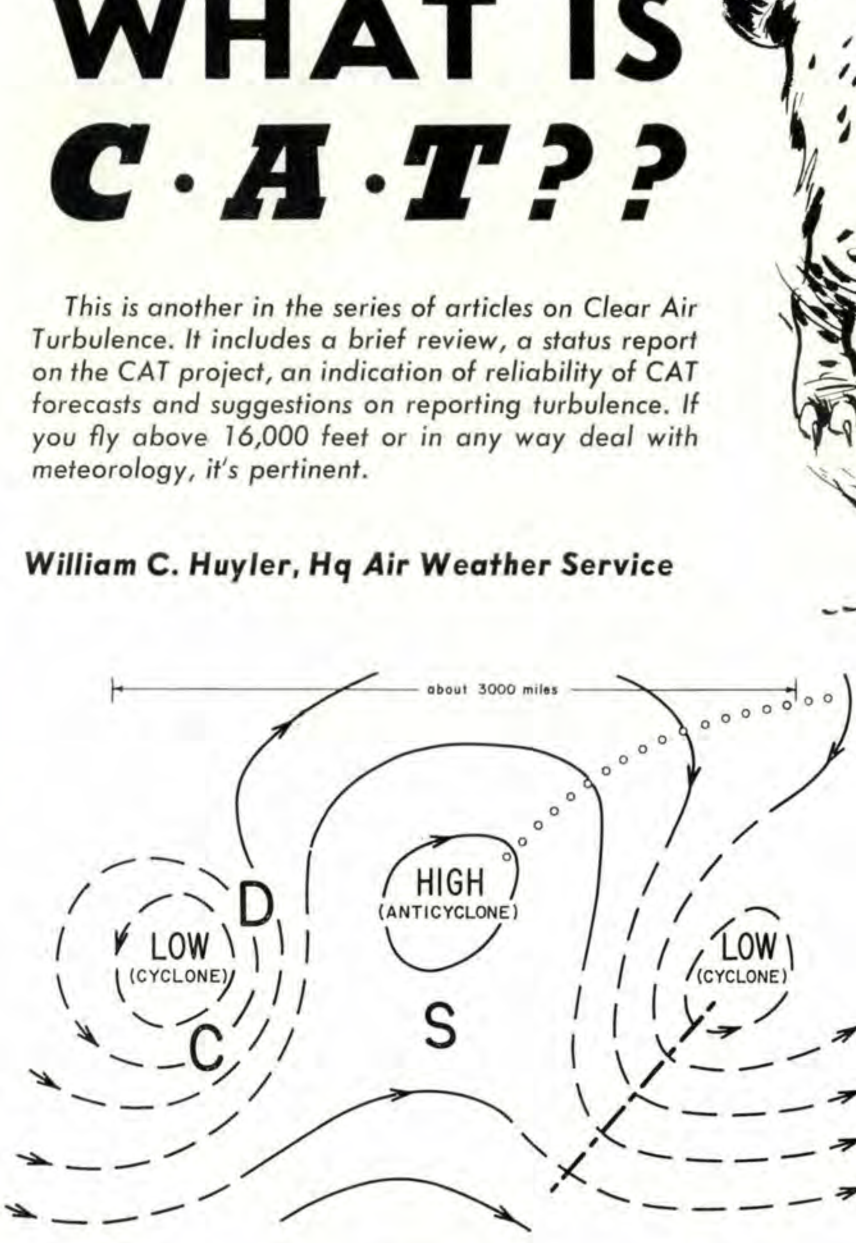


*Figure 1*

SECTION OF AN UPPER AIR CHART, A FULL SINUSOIDAL WAVE IN THE MEAN FLOW AROUND A HEMISPHERE NEAR 20,000 ft. IN THE MID-LATITUDE WESTERLIES.

*LEGEND*

*HEIGHT CONTOURS*
*Cyclonic curvature* - - - - -
*Anticyclonic curvature* ———
*Trough (maximum cyclonic curvature)* — - — -
*Ridge (maximum anticyclonic curvature)* • • • • •
*DIVERGENCE AREA (expansion of a flow)* — D
*CONVERGENCE AREA (contraction of a flow)* — C
*SHEAR - variation of velocity across a flow or across opposing flows.* — S

*Spacing between lines denotes airspeed variation; the closer the lines the greater the airspeed with direction parallel to lines and in direction of arrows.*
*Downstream - moving with the airflow - tailwind*
*Upstream - moving against the airflow - headwind*

CAT is any turbulence found above 16,000 feet except that found in or near thunderstorms or cumulus clouds. It includes turbulence found in cirrus type clouds and mountain waves. The energy resulting in CAT is obtained from two sources. These are the large displacements of air moving across mountains resulting in mountain waves and rotor effects, what meteorologists call "gravity waves," and the convergency or divergence of air in the sinusoidal—snakelike—flow of the atmosphere around the hemisphere, what meteorologists call "mean flow energy." (Figure 1.)

Mountain (gravity) waves have been highly publicized in articles and diagrams and their consequences near mountains are well known. Mean flow turbulence, on the other hand, is possible in most of the atmosphere (U-2 pilots have found it at extreme operating altitudes) as we know it today. This turbulence is due probably to a concentration of energy in the vicinity of the jet stream or other marked shear situations which create small scale eddies, both horizontal and vertical. To evoke a mental picture from non-flying experience, recall the image of the vortices and eddies about a jet of water from a hose flowing into quiet water.

About 70 per cent of the CAT pilot reports indicate that preferred CAT regions exist. These are where the jet stream splits, where the jet stream has strong cyclonic curvature and in the diverging field down wind from strong cyclonic curvature. In relation to the jet stream, significant CAT is most commonly noted below and to the left, and above and to the right, looking downstream. CAT is also frequently found in high altitude closed lows in the strong wind shear around these lows. In the stratosphere, we believe that opposing horizontal flows and cyclonic curvature play the most important role in producing turbulence.

It is interesting to note that horizontal eddies have to be about five times as strong as vertical eddies (gusts) in order to produce an equivalent vertical acceleration. Horizontal eddies produce uncomfortable erratic aircraft yawing, pitching and rolling motions and can, in transport aircraft flying in small uniform eddies, establish longitudinal resonance vibrations.

CATFS FORECAST RESPONSIBILITY. The following turbulence forecasting responsibilities are discussed so that you will know who does what, with which, and to whom, turbulence-wise.

CATFS forecasts turbulence greater than "light" for mountain waves and mean flow, whether in clear air or in cirrus cloud at levels above 16,000 feet over the ZI. CAT forecasts—and Outlooks—are issued twice daily. These are similar to the Severe Weather Advisories in that they contain three-dimensional areas or "boxes" in which turbulence is expected to occur. Each forecast is for a 24 hour period and contains an Outlook for the ensuing 24 hour period. They are distributed in the ZI over the military weather teletype circuits. CAT areas are plotted on a display chart in all weather offices as soon as received—about 0800Z and 2000Z. Outlooks are not plotted but are used for preoperational planning purposes.

AWS duty forecasters are responsible for preparing forecasts for any turbulence below 16,000 feet and for turbulence related to thunderstorms or other convective activity at any altitude.

PIREPS. The following paragraphs may be introduced by saying that PIREPs containing either positive or negative CAT reports are extremely valuable to the forecaster for producing turbulence forecasts. They are the only objective means of verifying CAT forecasts.

You are now asking, "How do I report turbulence?" Simple! Report your airspeed fluctuations in knots, i.e., "IAS VARIATION 30," if your IAS fluctuation was 30 knots. In some of his work, the meteorologist is interested in *true* gusts. Using known relationships he can convert this to true gusts or other meteorological information. For example, IAS FLUCTUATION 30—true gusts of 80 ft/sec at 40,000 feet. What we really want when you encounter CAT (or thunderstorm) turbulence is:

a. Location
b. Time, Zebra
c. Phenomena encountered
d. Altitude
e. Aircraft type
f. In or out of cloud
g. IAS fluctuation

The above format is contained in the FLIP Enroute Supplement

Direct reporting of airspeed fluctuations have the following advantages:

a. Maximum simplicity for pilots.

b. Increased precision of pilot reports, especially in cases of more severe turbulence (it is far more precise than the adjectival descriptions of light, moderate, severe, extreme).

c. Providing to the meteorologist simple and uniform interpretations of the reports in terms of derived and actual gust speeds.

d. Providing greater utility of the reports in flight planning.

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Last October, subsequent to many round table discussions, mostly on whether CAT forecasting was feasible, AWS established the world's first CAT forecast office (section). This unit, part of Detachment 42, 8th Weather Group, is collocated with the AWS Terminal Forecast Facility and the US Weather Bureau's Severe Local Storms (SELS) Forecast Office, and is located in the Federal Building, Kansas City, Missouri.

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Of course, this turbulence value will be contained in your COMBAR or in the PIREP you transmit and in the weather information you pass on to the AWS forecaster during debriefings.

Last May, all weather services of the United States adopted the simple system of using the airspeed indicator to measure airspeed fluctuations and correlated these with turbulence intensity as in the following table.

| INTENSITY | IAS FLUCTUATIONS |
|---|---|
| Light Turbulence | 0-15 knots |
| Moderate Turbulence | 15-25 knots |
| Severe Turbulence | More than 25 knots |
| Extreme Turbulence | Rapid fluctuations in excess of 25 knots |

The first such table was established by NACA in 1957 and was revised by NASA (formerly NACA) last February. It now provides the standard aircraft turbulence reporting criteria and is taken from the US Standard Meteorological Definitions of Turbulence.

Turbulence reports in terms of objective airspeed fluctuations are necessary. Through flying maturation, most pilots become less concerned with the turbulent bumps encountered in flight. However, while the aircraft they fly may take the roughest air of a mountain wave or a thunderstorm without structural damage, many aircraft in the DOD inventory must detour around severe or extreme turbulence areas to avoid popping rivets or splitting at the seams. For these reasons we really want the latest word from you (via Channel 13, PIREPs, debriefings or other means) on the degree of turbulence you encounter.

VERIFICATION. How are the CATFS forecasts proving out? Well, CAT boxes occupy around four per cent of the flyable aerospace between 16,000 and 56,000 feet over the United States. Twenty-five per cent of all CAT PIREPs were from within the boxes. There is, therefore, eight times as great a chance of encountering CAT within a forecast box than outside. This is especially significant when nowadays you do your flight planning to take you around rather than through the CAT boxes. ★


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