AEROSPACE

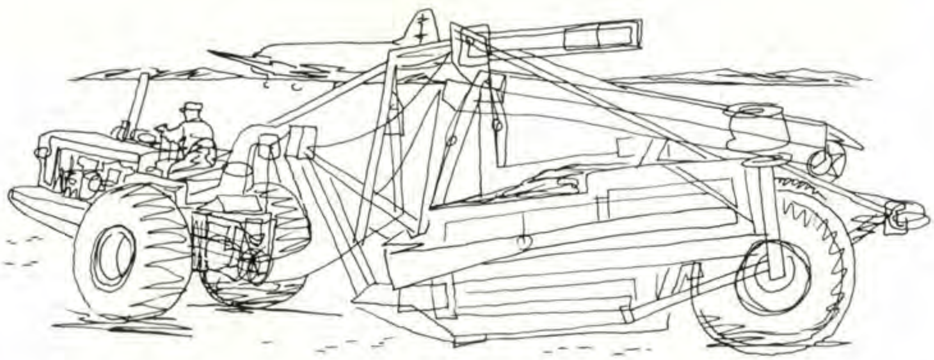
SAFETY

UNITED STATES AIR FORCE

the PROfessional

...one who makes his *LIVING* by his art.

MAY · 1962



THEY'RE AT IT AGAIN!

In the species homo sapiens there are groups that seasonally exhibit behavior characteristics to severely tax the patience of pilots. Typical of such are those commonly grouped under the general heading of contractors. Like half-starved bears just out of hibernation, they scurry about, speeded in their apparently aimless activities by an assortment of trucks, cranes, rollers, mixers, tractors and other assorted power equipment. Their endeavors are completely indiscriminate. At one end of an airfield they may be applying a new, smooth runway surface while at the exact same time another gang will be working every bit as industriously at the other end ripping their way through 12 inches of seasoned concrete. While these crews exhibit their respective constructive and destructive abilities, other allied crews demonstrate a penchant for neatness and identity by painting stripes, numbers, hatch lines and other marks on whatever concrete might not be disturbed. All this, of course, is accompanied by considerable vehicular traffic along, across and between the runway complex.

Crews stake their claims with wooden barricades, flags and flashing lights. They thus exhibit considerable pride over the little domain they have decided to break up, fix up or paint.

Weather has little deterrence on all this persistent activity. Work goes on in mud, slush or sunshine. Also, one crew seems dismayed by the fact that another crew may have to labor just as diligently to remove the residue.

All the while, pilots, who are just as anxious to follow their profession in balmy weather, are expected to negotiate their way over, around and through the shifting obstacle course set up by contractor groups. They can depend only on a few NOTAMS, a precautionary tip from an ops officer, garbled guidance via radio, keen depth perception, good brakes and a certain amount of psychic ability.

Pilots have long since ceased to fight the problem. They live with it as best they can. They worry about higher FOD rates, operate from shortened runways, squeeze around barricaded taxiway diggings and negotiate gingerly along cleverly trapped ramps. Theirs is not to reason why, to simply try and fly.

Those who have tried to reason all this out have given up. Evidence is virtually irrefutable that airfield construction is the most highly unstable effort ever attempted by man. By some unwritten but never contested law, frequent refurbishing is required. The same concrete footing that would support a heavy building for decades sometimes can barely make it from one season to another. This becomes more baffling when it is remembered that runway concrete is in use only minutes per day, and then merely to support the rolling weight of rubber-tired airplanes.

And, if a mistake were made in the batter and the runway does prove durable, there is always some fiendish gang that can disrupt its intended use for one pretext or another. It has to be painted, or dug up to run a conduit underneath or for centerline lights.

If these ruses won't work, another ambitious crew can do the next best thing—start a beehive of activity along its edges. There is almost no limit to this type enterprise. Livestock, either domestic or wild, can graze along it. Bare ground can be fitted, fertilized and seeded; then as the grass grows it can be mowed. Lights can be installed. If lights exist, they can be replaced. ILS buildings can be constructed, redecorated, repainted or replaced. Distances between can be remeasured. Taxiway turn-offs can be closed, or torn up and altered into high speed turn-offs.

Probably the choicest spots for contractor personnel to busy themselves, other than on runways, are the overruns. Over the years they have managed to exploit such areas almost beyond comprehension. Time was when they were satisfied to merely remove tall trees. Now, no trees of any size grow on overruns. Once the foot was in the door, all the trees disappeared. Then large rocks. Finally, they had all overruns graveled. Then periodic regraveling and leveling was required. (Most overruns were constructed with enough slope to allow for erosion—need for drainage being the selling point, of course.) This got to be too much of a good thing and "stabilization" evolved. Stabilization is a clever, work-perpetuating scheme. Enough coagulant is used to stop erosion, but not enough to take care of wear should pilots use this area. When prepared right a stabilized overrun will just barely support an airplane—it won't support very many airplanes very long.

What about the future? No hope! These persistent gangs show evidence of a high reproductive rate. In addition, forecasts are that with the advent of more efficient heavy machinery they can be expected in ever greater force.

We pilots can't spoil their fun. Watch them look up when a plane zips just over their heads. Look at it this way—if it weren't for the flying going on, there wouldn't be much adventure left in their enterprise. Most of the risk would be removed. The way it is now, it's like a game—how much can they do without having a pilot bash his machine. Over the years they have devised some mighty clever obstacle courses. Now they are entrenched, they are ingenious and they outnumber us.

Watch out! ★

IN THIS ISSUE

FALLOUT

Let's Face It

Your helicopter article, "Da Vinci's Pride" in the January issue, is an excellent presentation of essential information to improve the safety of 'copter operations. We would like to correct an erroneous impression, however, that could be created by the exaggerated photos of the H-43A that were used to drive home one of Major Kirkland's points:

The normal blade-to-ground clearance of the H-43A (also the H-43B) is in excess of 6' 4" at the lowest point of the disc. Anyone who has observed blade tracking operations, using a tracking flag, will recall how high the flag is above the holder's head. This clearance is as good or better than many of the smaller helicopters in service today, and it is a far cry from the knee-height clearance which your photograph depicted.

Of course, blade-to-ground clearance on any helicopter can be reduced by cyclic control, wind gusts, and rough terrain. We concur, therefore, that as a matter of habit all helicopters with rotor turning should be approached from the front. (Tail rotors, as well as main rotors, dictate this for safety.) If the photographs which you used will prevent even one accident of this sort, we will feel that the exaggeration was justified—provided the facts are also understood. With 150,000 hours on Kaman synchropters, there has been only one incident where a person walked into a blade, and this occurred when he approached down a hill. His hard hat took the blow and no injury resulted.

C. L. Morris, Asst Vice Pres
Field Service Manager
KAMAN Aircraft Corp,
Bloomfield, Conn.

Like the man said—it can happen. So, we repeat, for safety's sake, approach all helicopters from the front.

Personnel Locator Device

On page 6 of your January issue (The Problem of Sea Survival), you have a footnote referring to continuing efforts to provide a personnel locator device. This is true, but with a misleading implication. Motorola of Chicago has been working for several years on an all-transistorized emergency transceiver, the AN/URC-10, but so far as I know, it is not yet in production. The implication in your footnote that such devices are not yet generally available, however, is false. The U. S. military AN-URC-4 and similar sets are available, and although far from ideal are certainly better than nothing.

The British have for a number of years used the Ultra Electric Ltd. SARAH transceiver, a compact transistorized set, watertight, which clips onto the pilot's life vest and permits a search plane to home in quickly on the floating pilot. This has been credited with saving a number of lives of ditched RAF pilots.

The French have a similar set in their Thomson-Houston T.H. -C.986. It would appear sensible for the United States forces to swallow a bit of false pride and buy these sets from England and France until something as good is available from U. S. Sources. Is our "buy American" policy to continue at all costs—including the needless loss of lives of American airmen who ditch and cannot be quickly located?

If you publish this letter it may make some of the brass in R&D and Procurement mad, but it may also save a few lives if it succeeds in waking somebody up. If you don't, it's no skin off my back. I'm a civilian now, and my choice of over-water survival gear is limited only by my imagination and pocketbook, not by government policy or regulations.

Malcolm G. Murray, Jr
Box 410, Seroe Colorado
Aruba, Netherlands Antilles

The USAF is now using the URC-4 and URC-11 radios. The improved URC-10 is being procured. However, URC survival radios are not considered to be personnel locator beacons since they are not automatic and cannot be carried on the person. DIG/Safety has recommended that an individual type locator beacon, similar to the British SARAH be procured for AF use. Commercially developed items are currently being evaluated to fulfill this requirement.

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PROFESSIONAL APPROACH

Major General C. W. Cecil, Deputy Chief of Staff, Administration and Logistics, Headquarters Pacific Air Forces

Last August at Osan, Korea, an F-100 on a go-around from a GCA low approach suddenly pitched down and crashed into the runway, killing its pilot. This pilot, obviously fighting for his life in the few seconds available, took time to push the mike button and transmit "frozen stick."

This pilot's action was a manifestation of discipline and professionalism of the highest order. He was undoubtedly aware of his peril, yet he took the time to describe his trouble to others.

The professionalism displayed by this F-100 pilot is not a rare case. In PACAF, our aircrews successfully coped with over 700 aircraft emergencies during a recent nine months period. This is ample demonstration of a high professional capability when considering that any one of these occurrences could have resulted in an accident but for the precise and knowledgeable actions of the aircrew.

Today our pilots are better trained, more responsive and more capable than at any previous time since man began to fly. Nevertheless, in a force the size of ours, there will be a few dissenters and there will be times when reduction in the quality of supervision is manifested by nonadherence or noncompliance by certain individuals. For example, we had three accidents in a two month period involving flight training violations and lax supervision. Four aircraft and three pilots were lost in these accidents.

Command supervision is essential in maintaining constant readiness and there is no room for haphazard or poorly supervised practices. The safety of the flight crew and weapon system is one of our paramount concerns and the direct responsibility of the supervisors and commanders at all echelons. A commander can control the level of aircrew discipline within his unit and consequently must take those actions which will maintain this level at the highest degree possible. In PACAF we have implemented certain measures to assure positive and dynamic supervision of flying.

The senior local commander is prebriefed each day on all scheduled flying by the squadron commander or operations officer conducting flying. This briefing includes pilot qualifications; aircraft by tail number to include a maintenance history of at least the previous five flights; mission to be accomplished to include take-off time, routes and altitudes to be flown; fuel reserves; alternates; range times; weapon delivery methods to be employed; refueling rendezvous altitude, time and fuel to be off loaded; landing times and weather to include current and forecast, terminal, route, alternate and range; and any other factors considered pertinent.

Once the senior commander determines that the above are compatible with safe mission accomplishment, he will indicate his approval or change accordingly.

To insure the close surveillance of the day's flying program subsequent to the briefing and approval by the commander, an appointed duty officer not below the grade of major is responsible for supervising the entire flying schedule. This officer acts as a clearance officer for the commander regarding schedule changes because of weather, aircraft-pilot incompatibility or maintenance. These procedures bring the senior commander into direct association with the flying program and result in positive supervision of the organization at all times.

Another technique we are using to assure the desired standards of discipline, efficiency and safety includes a procedure for spotting and eliminating substandard performers from cockpit positions. Our personnel staffs throughout the command have been directed to conduct a critical review of the applicable personnel and training records of each aircrew member scheduled to fill a cockpit position. Those aircrews with records of inaptitude or repeated substandard performance are diverted from cockpit assignments. Requests to place a rated officer in a primary cockpit position are now forwarded to this headquarters for final approval. Intensified relationships between the flight surgeon and unit commander have been implemented. Utilizing these procedures, we can avoid the assignment and occupancy to cockpit positions of marginal performers and those with unsuitable physical or mental characteristics. In addition, these procedures identify the individual assigned to a command or key supervisory position who does not have the ability to lead. We believe that these procedures are much better routes to follow than waiting for mistakes to occur.

The change of supervisory personnel in PACAF during the peak summer rotation period of June and July appeared to infect some units with "letdown-itis." The three aircraft accidents referenced previously occurred when key commanders in the units were being rotated or had just departed. While we cannot say positively that this fact contributed to these accidents, we are taking positive action to avoid the deterioration of supervisory and production capability as a result of the heavy summer rotation and leave commitments; specifically, we have re-emphasized the following policies:

- Commanders reporting directly to Hq PACAF have authority for extending overseas tours to permit the orderly and systematic rotation of personnel consistent with mission accomplishment.
- Commanders will insure that the absence of AF members on leave status during the summer rotation period does not contribute to the degradation of unit capability. Careful consideration must be given before granting leave to nonrotating personnel who are assigned to work in areas directly affecting the tactical mission.

We have not neglected the mission support (CRT) program in our emphasis of command supervision and professionalism. These pilots, being older and with long years in the business, are not as prone to commit undisciplined acts in the air. They are more likely to commit errors of omission.

Our approach to the problem of assuring that the proficiency of the mission support program pilot is maintained at a safe level has been to increase the frequency with which he is spot-checked by an instructor and the employment of formal pre-mission briefings intended to give him an up-to-date knowledge of local flying conditions and keep him cognizant of emergency procedures and aircraft handling techniques. Commanders of such units are not exempt from the requirement to be prebriefed on all scheduled flying. The same procedures outlined previously apply.

One of the more serious problems we have had in PACAF is the repeated accidents caused by aircraft systems deficiencies of long standing. One example is the F-102 constant speed drive oil system problem. This problem has been identified for several years and corrective technical orders have been issued since July 1959. The Tech Orders, however, have been cancelled and reinstated several times, causing delays in the receipt of kits. Consequently, our F-102 units were forced to operate aircraft with unmodified oil systems. There are other cases such as the J-57-21 after burner leakage and turbine front bearing support assembly problem, the notoriously weak landing gear on the F-102, and the flight control lock-up problem on F-100 aircraft. This is clearly *not* a professional approach to flying.

We have identified these and other "materiel failure" problems and have repeatedly encouraged the responsible agencies to take appropriate action with accuracy and speed. In addition, we have geared our maintenance capability and efficiency to the utmost in an effort to combat "materiel" failures.

These then are some of the actions we have taken in PACAF to assure proper standards of supervision and professionalism in flying operations in our organizations. We believe command supervision and professionalism to be the two most important elements in the conduct of a safe operational program. It all adds up to the absolute need for an overall professional approach toward modern combat flying. You are dead without it! ★

PROFESSIONAL???

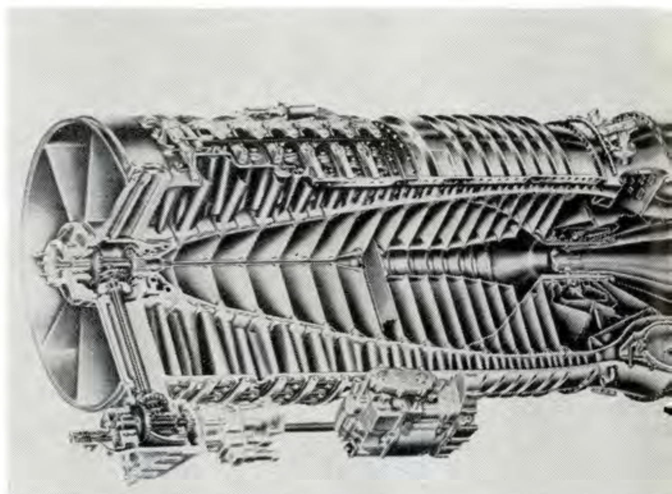
The pilot of the transport had made his passenger stop and was ready to head for home. He knew he had a leak on one of his propellers but figured he could make it.

On runup he had an overspeed on the sick prop but still figured he could get a hot meal at home. On takeoff the propeller oversped again and the C-130 entered the pea patch. The pilot *still* thought he could make it home without the benefit of runway!

He made his takeoff—even though he left his gear along the way. A cold supper would have been better in the end. ★

READ 'EM OR WEEP

Ralph McCreadie,
Service Training School
General Electric Co.



Sound judgment is based on knowledge and the ability to apply this knowledge at the proper time, in the proper manner.

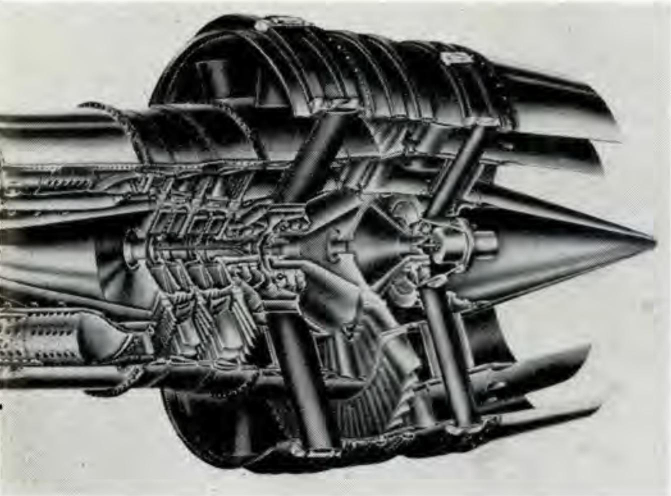
In pilot training, a working knowledge of information contained in the *Flight Manual* is necessary. Knowing what to do in an emergency as outlined in the manual has saved many lives and millions of dollars in equipment, and will continue to do so. One of the opening statements in any *Flight Manual* reads, in part, "This book provides the best possible operating instructions under most circumstances, but is a poor substitute for sound judgment." When an emergency occurs that is not covered in the manual, whether the pilot responds properly depends to a large extent on him as an individual.

The jet engine of today is a highly complex machine, yet an understanding of an engine's individual design philosophy is important. Each type of engine has its own characteristics. These characteristics must be understood by the operator in order to properly recognize, analyze, and correct a trouble.

A logical question, then, is, "What sources of information are available to a pilot who desires to gain a functional knowledge of an engine's operating characteristics?" Reading and understanding the *Flight Manual* should be his first source. Another source might be other pilots familiar with operating this type of engine. If the engine is new to the base and there are no experienced pilots, the local service representative should be contacted. He has been trained and is qualified to answer questions relative to his company's product. Usually, a proper indoctrination can also be obtained from the available special training programs and publications. Information concerning these publications and programs may be obtained from the base Education and Training Office.

Once knowledge of engine philosophy has been obtained and normal operation has been observed and understood, one of the more important trouble shooting aids available to a pilot is the engine instrument group in the cockpit. Among the more common engine gages are:

- Exhaust Gas Temperature
- Engine Speed
- Fuel Flow



- Variable Area Nozzle Position Indicator
- Exhaust Gas Pressure Ratio Indicator
- Engine Oil Pressure
- Engine Oil Temperature
- Aircraft Boost Pump Pressure
- Engine Air Inlet Pressure

The specific grouping of engine instrumentation found in a cockpit depends on the particular type of engine or particular manufacturer. However, regardless of the specific instruments which a particular application may have, those which are available are valuable tools which the trained operator can use to observe a problem, analyze it, and through sound judgment, take the necessary steps to correct it. In other words, engine instruments tell a story. If the pilot understands their language, instruments become an invaluable aid.

Engine instruments can be divided into two categories, thrust indicators and support system indicators. Included in the first group is engine speed. This is an indication of air flow and is useful in determining thrust. With a single spool fixed tailpipe configuration, engine speed can be used as a prime thrust indicator. However, an engine with variable stator geometry or a variable area nozzle can use engine speed as a thrust indicator, but must also use fuel flow and exhaust temperature in determining the final value of thrust. Still a third type, the dual spool configuration, may use engine speed, not as a prime thrust indicator, but as a reference point for establishing engine operating conditions. However, in all these different configurations, engine speed has a definite effect on thrust. Exhaust gas temperature also plays an important part in determining thrust output. When referenced to engine speed, temperature may be used as an engine condition instrument. Exhaust gas temperature too high or too low for a given engine speed will change the thrust output of the engine. Also, the exhaust gas temperature indication should be used to monitor the structural integrity of the turbine. In order to obtain design life from a turbine, conscientious monitoring of EGT is essential. This is particularly true during transient conditions.

Fuel flow is another important factor in determining thrust. The fuel flow indication, when compared with engine speed and exhaust gas temperature, provides another tool for realistic analysis of engine thrust output. Generally, changes in fuel flow result in changes in both engine speed and EGT. However, in the case of an engine equipped with variables, this is not necessarily true since air flow, which is one control of fuel flow, will be affected by variable IGVs, stators, and exhaust nozzles.

For example, if an engine's variable stators should fail closed at a high power setting, the reduced air flow would unload the compressor to such an extent that fuel flow requirements would be reduced. Assuming no throttle retard, the main fuel control would reduce fuel flow to schedule only enough fuel to maintain the selected speed. Exhaust gas temperature would remain high due to the overall fuel air ratio necessary to maintain the desired speed. The end result would be rated speed with a probable overtemperature, but fuel flow much too low in comparison with a normal engine. Such a condition would obviously result in low thrust. In other words, fuel flow is a directly related indication of engine air load. The fuel flow indication is also useful in establishing a cruise power setting.

Another thrust indicating instrument is the variable area nozzle position indicator, when used in conjunction with engine speed, exhaust gas temperature, and fuel flow. Knowledge of the relative position of the nozzle under various conditions of operation is useful in determining engine back pressure and, as a result, its effect on fuel flow, EGT, and engine speed.

A special thrust measuring device found on certain

READ 'EM OR WEEP

CONTINUED

types of engines is the exhaust gas pressure ratio indicator. This indicator system measures the pressure at the inlet of the engine and compares this in a ratio form to the pressure in the tailpipe. Studies of this relationship have shown that operation of a particular engine under a specific set of conditions with a given pressure ratio will produce a specific amount of thrust. This type of instrument is most applicable to an engine with a fixed or two position nozzle because its calculation of thrust is based on a specific pressure ratio across a specific tailpipe area. Due to the wide range of changes in area of a completely variable nozzle, a pressure ratio indicator is not useful in most engines with variable nozzles. In addition, this indication is also useful in determining cruise power settings.

Included in the support system indicators are engine oil pressure and engine oil temperature. Oil pressure is necessary for monitoring the lubricating and cooling qualities of the oil system. Engine oil temperature may be used to provide an indication of oil cooler operation on an application where engine oil is under heavy load.

Aircraft boost pressure, also a support system indicator, is sometimes helpful in determining the source of a fuel system problem and is generally included in the cockpit instrumentation group. However, it is often overlooked as an engine trouble shooting instrument. Under certain flight conditions, aircraft boost pressure is necessary to assure an adequate fuel supply to the engine fuel system. Monitoring the aircraft boost pressure may be of significant value in locating and correcting any problem associated with inadequate supply of fuel to the engine.

The last, although certainly not the least important, instrument included in the above list is the compressor inlet temperature gage. Its value as an indicator of engine performance increases considerably as engines become more and more complex and aircraft speed continually increases. Some engine control systems use compressor inlet temperature to compute schedules of engine speed, acceleration fuel, and other engine variables. In order to know if these schedules are correct, it is necessary to compare the CIT gage indication with other cockpit gage indications. The pilot must possess a working knowledge of the proper relationship between these indications in order to obtain maximum benefit from the CIT gage.

As mentioned earlier, these are the "tools" with which a pilot can analyze malfunctions and, through application of knowledge and sound judgment, make decisions and take action which could save his aircraft and, possibly, even his own life! Practical application of a few instrument uses in decision-making is included in the examples which will follow.

One of the more serious problems that may be encountered in any turbojet engine is compressor stall. Axial-flow compressor stall may perhaps best be understood by comparing it with stall as encountered on an airplane wing surface. Envision a cross section of the wing (air foil) in a head-on, smooth free air stream. The air foil is so designed with certain other considerations to allow smooth streamlined air flow over its entire surface. (See Figure 1.) As the angle of attack of this air foil is increased relative to the direction from whence the air is flowing, it becomes increasingly difficult to maintain this charcteristic smooth air flow. When the wing reaches a certain critical angle of attack, the air flow on the top of the air foil suddenly separates from the smooth streamline form and becomes rough and turbulent. (See Figure 2.) This imparts a high drag and resultant loss of lift to the air foil.

An axial flow compressor is made up of hundreds of small wings or blades and during a compressor stall this same happening occurs on portions of the blades of one or more of the compression stages. Since the blades are fixed, they do not physically move to different angles of attack. However, an increase of angle of attack, in effect, is caused by the decrease in air flow resulting from excessive fuel being injected into the combustion system for a given speed, such as happens

Figure One

during engine acceleration. In such a case, the increased rate of combustion causes a rise in combustion temperature which, together with the fixed area turbine nozzle diaphragm, effectively throttles the compressor discharge, causing a decrease in compressor air flow and accompanying increase in compressor discharge pressure. These effects occur because the compressor sees an effectively smaller area in the turbine due to the higher combustion temperature. If these changes in angle of attack are of sufficiently large magnitude, the blades stall, immediately causing a drop in compressor efficiency due to the increased drag and a drop in compressor pressure rise due to the loss in lift. When this action occurs, part of the compressor blading will be operating normally while the remainder will be operating stalled and thereby passing relatively little flow. Although this condition can persist in certain cases, the more normal occurrence is as follows: The pressure immediately downstream of the compressor is at a higher level than that which stalled portions of the blading are producing. A blowback of air results with the high pressure discharge air relieving itself by flowing forward through the stalled portion of the blades. The effect of this is to relieve the flow area of the unstalled portion of the blades. This then allows them to pump more pressure and move the compressor out of stall. The process then repeats in a cyclic manner at a frequency largely governed by the volume of the inlet and discharge ducting. The cyclic phenomenon is known as pulsation. Combustion system instability and fuel control system characteristics play an important role in pulsation.

One of the best ways to detect stall in aircraft installed engines is to observe the tachometer and exhaust gas temperature indicator when making accelerations and decelerations. If the exhaust gas temperature continues to increase while RPM holds steady or falls off, the compressor has stalled and quick throttle retardance is required. In addition, a loss of thrust will be encountered, accompanied by abnormal engine vibrations and hissing sounds during the actual stall condition. In cases of violent stall, a "whoof" sound generally emanates from the engine air inlet often accompanied by flame. Violent shudders will occur, the exhaust gas temperature will climb to overtemperature values, and there is possible danger of engine damage.

For turbojet operation, instrumentation of the compressor discharge pressure would offer a much faster and more positive indication of stall than merely tachometer and exhaust gas temperature indication. This is

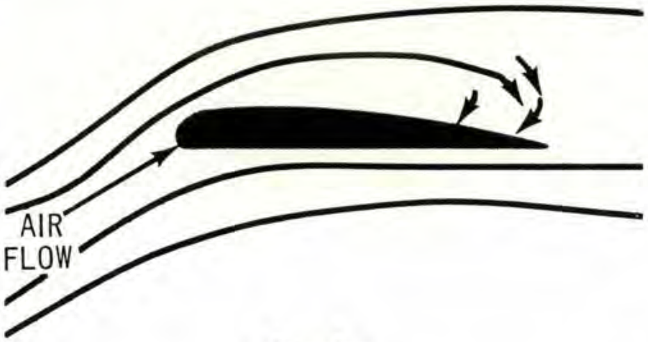


Figure Two

particularly true during accelerations and a stall condition would be indicated by a halt or decrease in the rate of compressor discharge pressure increase. However, this parameter is usually not included in a normal cockpit instrumentation group.

Since during stall engine RPM tends to fall off due to the resulting compressor drag, the main fuel control attempts to maintain RPM in the only way it can—by injecting more fuel into the combustion chambers. Aside from aggravating the stall condition by increasing temperature build-up, the resulting combustion causes temperatures far in excess of safe design limits and causes extensive damage to "hot parts" such as combustion liners, transition liners, nozzle diaphragm, turbine wheel and buckets, and exhaust cone. The sudden reversal of compressor air flow, as may occur during a compressor stall, can cause compressor blade bending and possibly compressor blade failure.

Today, as a rule, all production-type engines are designed and can be adjusted to prevent compressor stall, but it is that occasional "exception to the rule" which one must be alert to detect. When making throttle movements, follow recommended procedures, but *always* monitor engine instruments. Also, if a stall condition does occur, the *only* recommended way to recover is to retard the throttle quickly. Stalls encountered in flight can best be recovered from by following the procedure specified for the particular type of engine involved. Intensive investigation has been accomplished to assure that the procedure given is the best means available.

The more variables an engine has, the more attention must be given to the cockpit gages. An example is a single engine fighter equipped with a variable area nozzle and afterburner. In the event of a failed open nozzle, you should know the answers to the following questions: First of all, how serious a problem is it and what cockpit gages will reflect the open nozzle? Assuming that the airframe is equipped with a variable area nozzle indicating gage, it should indicate open. Even if it were inoperative and did not, other engine gages would give the indication. Fuel flow would be lower due to less back pressure. Thus, exhaust gas temperature would be a lower value. Exhaust gas pressure ratio would indicate lower. The result would be lower thrust. How much lower, and can you make it back to the base? What effect would this type of operation have on other engine components? Would attempting an afterburner light be of any value in this situation? Is there an emergency nozzle closure system? The answers to these questions and any others you may form should be known in advance of this possibility.

The lubrication system can also cause a pilot to make important decisions. For instance, he may be faced with such questions as: "How long will a particular engine endure and still produce power with zero oil pressure?" "What is the proper power setting for this particular engine that would give maximum engine life under this condition?" "Does any engine system other than the lubrication system require engine oil for its operation?" Once again, careful monitoring of cockpit gages will give the pilot a maximum amount of time to consider a problem and establish the proper corrective action. Don't end up saying, "The first thing I knew the engine was frozen."

Engines that use the engine oil supply other than to lubricate the bearings and gear boxes are becoming more common. Engine oil may be used to operate such components as a constant speed drive, a variable area nozzle; or perhaps, a variable engine inlet geometry. The engine oil supply on one particular fighter is contained in a single oil tank. Three pick up points are located at three different oil levels to supply three separate systems with engine oil. The three different levels of pick up establish a priority system; so that in the event of oil loss, the least necessary system will fail first. Recognition of this failed system and realization of its tie-in with other more important systems may give the pilot advanced knowledge as to possible future and more serious problems.

The main fuel system is primarily concerned with maintaining engine speed. Whenever a malfunction concerning engine speed occurs, the first thought should be: "Is the indication correct or could the engine speed indicator be at fault?" The answer to this question may be determined by observing other engine instruments, particularly fuel flow and exhaust gas temperature. If these indications are normal and only engine speed is abnormal, the fault may be in the indicating system; however, if these indications are also abnormal, the fuel control system should be suspected. To check the ac-

READ 'EM OR WEEP CONTINUED

curacy of these indications, it should be determined if exhaust gas temperature is compatible with fuel flow. It is possible for the main fuel control to maintain desired engine speed even though abnormal indications exist. This condition may exist due to improper positioning of engine variables (i.e. stators, nozzle). In other words, these maladjustments may change fuel flow requirements necessary to maintain desired engine speed, and the fuel control system will regulate fuel flow accordingly. Therefore, any malfunction indicated by an abnormal gage reading of engine speed, fuel flow, and/or, exhaust gas temperature should be analyzed carefully so as to distinguish between causes and results. Even if inflight adjustments are not required, all abnormal indications should be noted and reported. Ground crew personnel depend on the pilot for a resume of the problems encountered in flight and the corresponding instrument readings taken at the time of fault.

The ability to understand the instrument language is one that is not easily mastered, but once learned, is another step in increasing the proficiency of any pilot. Cockpit instruments stand as instruments of direction. When an accident has been prevented, or a malfunction corrected, the diagnosis for corrective measure is usually based to a large extent on an understanding of the instrument language. ★

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$$ THREE MILLION DOLLARS OF SAFETY $$

Monetary evaluation of accident prevention is rather difficult to support; but gear-up accidents are logically quite costly, especially when you consider 12 damaged props, 12 engines, and a couple of expensively equipped radar domes, not to mention other probable associated damages.

Essentially, this is our claim: prevention of four gear-up accidents during a period of 18 months. The aircraft involved were two RC-121s, one WB-50, and an F-86. The F-86 was the only aircraft that experienced an actual emergency in the form of an oscillating nose gear after a down-and-locked indication was observed.

Each of the aircraft made a go-around at the last possible moment. The pilots of three of the aircraft were warned by a runway flare system after radio instructions failed to alert them to a gear-up condition. The other aircraft was finally contacted and a go-around was initiated at less than 50 feet altitude over the overrun.

There were other cases of aircraft making approaches sans gear, but they were warned in time by radio. In a couple of cases, the pride of completing the approach outranked the prudent course of action, and the gear was lowered over the overrun, or during the landing flare.

These aircraft "saves" are the result of a *runway observer program* here at McClellan AFB, Calif. The system consists of a mobile control van and runway flares. The van is manned by observers from Base Operations, trained to recognize various conditions hazardous to aircraft in the landing or takeoff phase. The observers are scheduled for two to four-hour shifts during daylight hours. They do not normally control traffic in any manner. Warnings are relayed through the tower. In an emergency, the observer may contact the pilot and activate the flare system.

Observers have detected fuel syphonings from aircraft before and during takeoffs. Aircraft taking the runway with speed brakes extended, bomb bay doors open, or improper flap settings have been detected and the condition corrected due to the observer's service. Observation of short landings, barrier damage, and debris on the runway are other beneficial results.

Mobile control units are responsible for a large amount of pilot assistance and accident prevention at bases where an intense training program is being conducted. Under similar conditions, the runway observer program is also reaping benefits at McClellan. There is widespread concern about the number of gear-up accidents that occur throughout the Air Force. The circumstances surrounding these saves have been pointed out in past accidents as contributing factors; the main factor being pilot distraction due to repeated landings and takeoffs, simulating emergencies during the landing pattern, and intensive instrument and transition training.

Ground assistance to our pilots at critical moments of flight is often responsible for increased longevity. We feel that the assistance provided by the runway observer program during the critical phases of flight, landings and takeoffs, is extremely valuable. In fact, due to the aforementioned results, we feel it's 3 million $ of $afety. ★

Maj. Wendell L. Mason, Chief, Safety Office, McClellan AFB, Calif.

PISTON PATTER

The C-123, under command of Captain Charles C. Yoos, had proceeded north from Alaska, performed a resupply mission to Ice Station Bravo, returned, and was letting down for landing at Elmendorf AFB. During accomplishment of normal prelanding checklists, the landing gear indicator showed the nose gear still up. Visual examination disclosed that the trouble was not in the indicator—the nose gear was up. No problem. Pull the emergency uplock handle. But the cable broke off in the hand of the flight engineer. The nose gear remained up.

The tower controller was advised of the emergency and he, in turn, notified sections that could possibly provide assistance. Fast thinking men in the maintenance section, in an effort to best evaluate the emergency and provide a solution, hurriedly jacked up another C-123 in order to simulate the airborne problem. As a result of their analysis, the flight crew was advised to chop a hole in the bulkhead and attempt to release the nose gear uplock. As the flight engineer began removing items from the bulkhead to facilitate cutting the hole, the pilots decided to recycle the gear one more time. This time the uplock released and the gear extended.

A normal landing followed, with the nose lowered gingerly. The gear held, but the ground locking pin had to be forced into position.

Here is an example of a potential accident that turned out to be an incident, and an example of highly commendable efforts on the part of specialists on the ground to assist aircrews in trouble. ★

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CHOPPER CHATTER

Lt Col James F. Fowler, Transport Branch, D/FS.

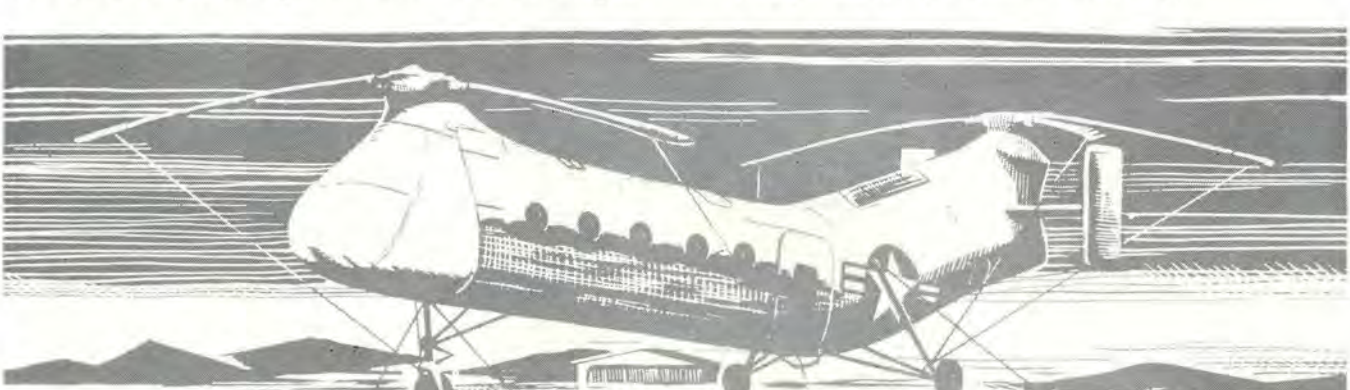
Four times in the past four months the H-21 chip detector light had come on. Not once had the engine failed. Want to guess what the reaction might be when the light comes on for the fifth time? Here's the situation:

Takeoff with 1800 pounds of fuel, en route to home station—seven passengers and a crew of two, and 35 miles from destination—the light comes on, engine RPM, temperature and pressure indicate normal.

The boys up front chose to ignore the Dash One instruction that says to make an immediate precautionary landing at the nearest suitable landing site available. After all, weigh the evidence and make a decision. Four times before the light had come on and no engine failure had resulted. Home was only 35 miles away. Everything looked okay . . . just because the book says so . . . They didn't ignore the light completely. They climbed up to 1300 feet, notified the base of their situation and even had an Air Rescue C-54 make an intercept. Mission motivation reigned supreme!

On to destination! Well, actually 10 miles short, 'cause that's where the engine surged, quit, and they made their "precautionary" landing—autorotation type. The IP, who was flying from the copilot's seat, took over when the light-foretold event finally occurred and terminated the mission with no damage to aircraft or property.

Lucky—not really safe—but lucky! ★



THE '97 IN '61 PICTURE

1961 was a good year for C/KC-97 operations from a safety standpoint. During the many hours flown in 1961, only one major and one minor accident occurred. The low major aircraft accident rate is a particularly impressive figure as it represents the lowest rate achieved during the 15 years of C/KC-97 operations. It is also the lowest rate achieved by any transport type aircraft. This excellent safety record and accomplishment is a tribute to all personnel associated with the C/KC-97 aircraft. This rate is especially noteworthy when we consider the factors of aging equipment, materiel deficiencies, inexperienced personnel, equipment conversions and mission tactics and requirements.

Although only one major and one minor accident occurred during the year, there were many near mishaps. The numerous incident reports, emergency unsatisfactory reports and operational hazard reports clearly confirmed the hazardous operations, materiel deficiencies and other areas of concern. The line of difference between a near accident and a major accident is very thin—maintained only by thorough aircrew training, crew knowledge of the aircraft and its systems, strong standardization programs and proper maintenance. Continued emphasis on these factors will do much to continue the fine record achieved in 1961.

The conscientious and accurate reporting of operational hazards and materiel deficiencies has been a very

Lt Col Gordon D. McBain, Jr., Transport Branch, Bomber/Transport Div., D/FS.

effective method for apprising operational and materiel agencies of the safety of flight problems in this aircraft. This reporting medium has been one of the most important implements of the accident prevention program.

To assist in further improving the C/KC-97 accident rate for 1962 over the excellent rate achieved in 1961, it would be advantageous to review those major problems that have plagued operations and effected the accident potential.

Emergency unsatisfactory reports received on R4360-59 engines installed on KC-97 aircraft indicated an increase in turbo supercharger failures. These turbo failures frequently resulted in fire and minor aircraft damage, and have been the primary cause factors in two major accidents prior to 1961. In addition, these failures have been a major reason for premature removals of 4360-59 engines. Investigation of failures revealed most were due to bearing failure resulting from improper lubrication, inadequate preoiling, oil contamination, inadequate inspection procedures and turbo overspeed conditions. Several actions were taken to correct these deficiencies. These included modification of the turbo nozzle boxes to incorporate a heavier rear shell for withstanding more heat cycles and revising the Dash One handbook to require turbo "cut-in" for a period of one minute during each 10 minutes of ground operations. An additional important improvement in turbos was achieved through the installation of temperature probes. This temperature indicating system, TO 1C-97-611, will provide sufficient warning of impending turbo failure to prevent complete destruction of the unit. Concurrently, an excellent color film (TF-1-5425) has been produced covering the installation, maintenance and inspection of turbo superchargers. All C/KC-97 organizations should fully utilize this film which is available through the Air Force Film Library.

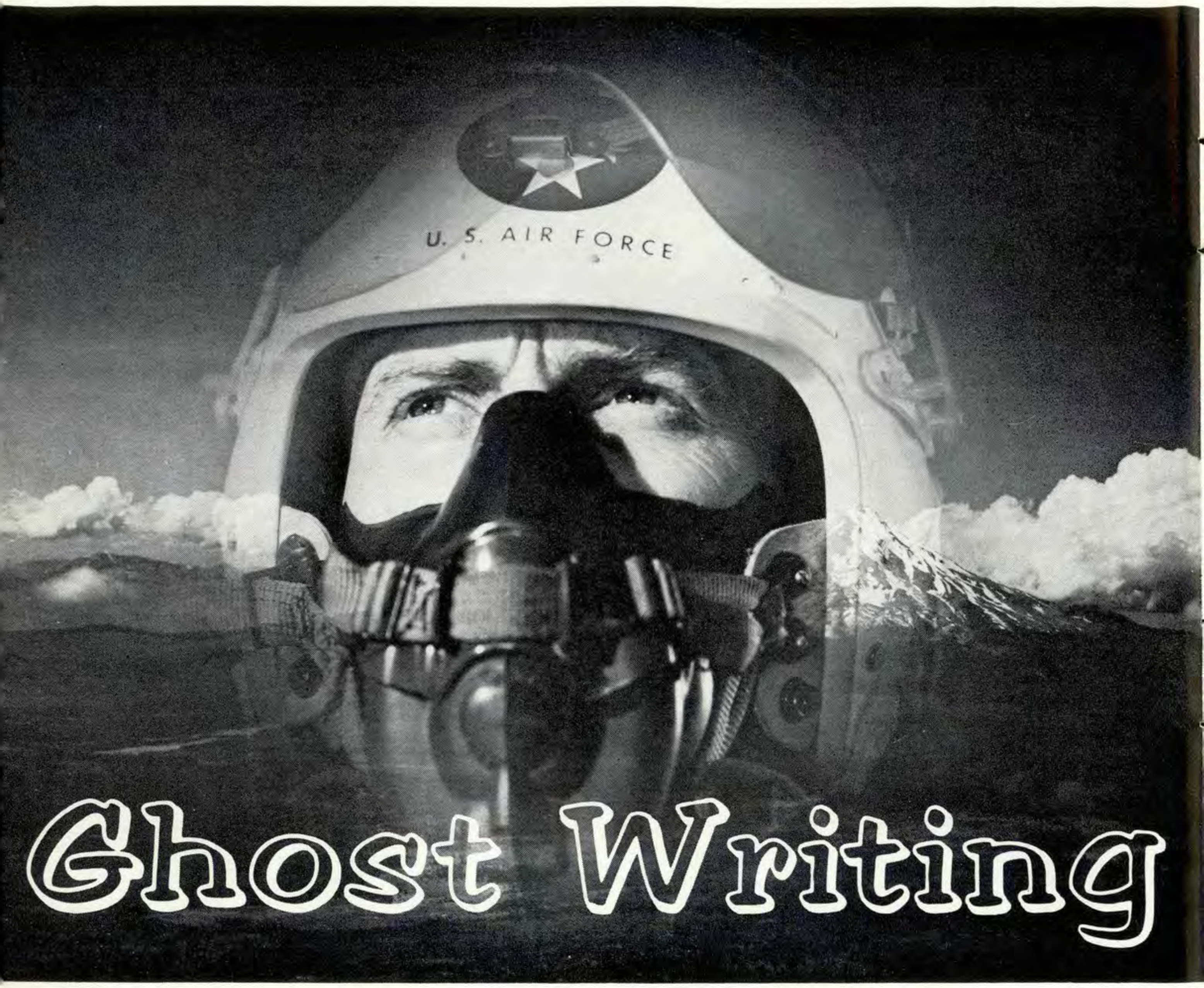
Failure of landing gear mechanisms within 60 to 90 days after overhaul resulted in numerous mission aborts, excessive maintenance and down time, and represented a serious safety of flight hazard. Engineering and quality materiel improvement programs revealed the following deficiencies in the overhaul procedures utilized in landing gear mechanisms: improper clutch pack installation; ball bearing kits out of tolerance; improper switch settings; failure of switch strikers; and inadequate lubrication of clutch packs. These deficiencies are being corrected through improved overhaul and inspection procedures. In addition, each overhauled mechanism is being operationally tested prior to release.

Numerous incident reports indicated that additional preventative maintenance would help prevent landing gear malfunctions. The one minor accident that occurred during 1961 was caused by failure of the landing gear retraction mechanism. Investigation revealed that a broken spacer ball caused excessive friction to the retraction mechanism which burned out the normal electric motor. Due to improper installation of the lock ring during overhaul, the bearing retainer unscrewed out of the housing. This movement eliminated emergency clutch travel and prevented disengagment of the normal motor and engagement of the manual system. As a result, the main gear could not be locked down. Only the professional performance of the crew prevented the crash landing from being a major aircraft accident.

Another serious safety of flight deficiency has been R-4360 engine vibration. Worn counterweight damper and engine operation between 2100 and 2340 rpm have resulted in propeller blade stress beyond limitations. Four propeller blade tip failures have occurred during recent months. Restrictions on engine operations in the 2100-2350 rpm range were imposed and TO 2R-R4360-550 was established to provide for improved bronze liners in the rear counterweight support instead of silver flashed liners. In addition, a new reliable method of testing engines for excessive vibration has been proposed for in-the-field use. Plans are underway to expedite corrective actions in order that operating restrictions on individual aircraft may be removed.

The high number of engine shutdowns and failures continue to adversely affect mission accomplishments, and have in some instances been the initiator in the chain of events that led to a major accident. Engine failures or malfunctions during critical phases of flight require the utmost of a crew's technique and abilities. An engine failure during takeoff on a heavyweight air refueling mission set the stage for the one major accident that occurred in 1961. A review of engine shutdown reports revealed that many of the engine problems had resulted from maintenance malpractice, errors due to the low experience level of some maintenance personnel, lack of adequate supervision, and improper engine operation by the flight crews. The high power demands placed on the 4360 engine by mission requirements dictate that all personnel, both ground and aircrew members, follow established procedures to the letter.

The continuation of good crew training, rigid standardization programs, thorough flight planning, adequate supervision and strict air discipline, coupled with quality maintenance, will provide the prerequisites required for another year of safe flying in the C/KC-97. ★



Ghost Writing

Listen to me, all of you non-ghosts. Maybe being a ghost isn't so bad—I'm not going to tell you because it might influence your judgment — but you already know it's the worst thing that can happen to next-of-kin. I will tell you how I became a ghost. If you want to, you can probably duplicate the procedure. Or you can remember this story and maybe you won't become a ghost, at least not the sudden way I did.

Before I was a ghost I was a pilot. I had been a pilot quite a long time, had flown many different airplanes and felt quite at home in the cockpit. I guess you could have classed me as an average pilot. I knew almost everything I had to know but not quite all I should know. I had made a few mistakes, but had made them high enough, or someone had noticed them and corrected me, or maybe a few times it was luck—anyway I had gotten by for quite a few years before I became a ghost.

Well, anyway, as I said before, I was quite at home in the cockpit. One night I was flying in a T-Bird, thinking about a redhead in Memphis, when I got this flameout. Now, I don't care how many times you may have simulated this, when it happens for real it will give you a real strange feeling, right now!

I knew my airstart procedures real well and was into them right away. Nothing. I probably ran through about half a dozen real fast before I could slow down and analyze my situation. I checked my airspeed, altitude passing through FL 270 and engine instruments. I even noticed the lights of a large midwestern city at the eleven o'clock position. Then I went through the airstart procedure, step by step, thinking out each as I did it to make sure I hadn't been missing something. Nothing.

I remember that it seemed warmer in the cockpit somehow. I was checking the altimeter more often and banked over to head for the lights. Something kept at me to hurry. I had difficulty making myself slow down and think. The guy in back said something. I don't remember what. I told him, "I'll get 'er going in a minute." I remember how surprised I was that my voice sounded natural to me. It was almost like a dream. I'd never had a real flameout before. It was hard for me to believe. I don't remember thinking about it, but noticed my left hand was checking the chute harness and chin strap.

I continued to try for an airstart. Right after 20,000 I took a good look at the lights and picked out a rotating beacon—then the lights of a runway. I headed for it, instinctively.

For the first time I thought of ejecting. I knew the procedure cold. I had practiced it lots of times. But I had practiced flameout landings lots more times. Besides, the cockpit was familiar. I didn't know what it would be like out there. I wouldn't go yet. The altimeter showed 12,000 feet.

"Declare an emergency. Tell them we are going to land down there," I told the guy in back.

I heard his voice on the radio but didn't catch what he was saying. I was concentrating on planning my approach and still running through airstarts as fast as I could. It was warm in the cockpit; awfully warm, and quiet. I swung around on high key, holding the nose up a bit. The airspeed was just under 150. I'd have to tighten the pitchout. I dropped the gear and honked over. On downwind I picked out the runway over my left shoulder. Farther back than it should be. Must be a wind shift at altitude. I hauled around toward final.

"Eject!" I heard the guy in back call, then was hit with the wind when the canopy left. I almost reached for the handles, but thought I could still make it. I'd hold the flaps.

Then I knew. I was too low. Airspeed 120. Field elevation. I hadn't considered that. I pulled the handles.

That's how I became a ghost. Believe me, mister average pilot, it could happen to you too. I've talked this over with quite a few other ghosts. One or two did exactly what I did. A lot more got here by doing things almost the same way. One I talked to the other day took nearly a hundred people with him. He was a recip pilot. He had it made with two engines out. But, low and slow, he decided to swing a bit wide and land on a longer runway. He lost power on a third engine and hit an embankment, still turning, a quarter of a mile out. He pals around with another ghost who lost an engine two hours from destination, overflew a dozen adequate fields, then, on final, lost another engine on the same side. He had gear and flaps down and lost airspeed rapidly when the second engine quit. He was below minimum control speed when he poured maximum power on the good side. His was one of the more spectacular ones. He swerved off to the right, the right wing went down, dug into the side of a hangar and turned his plane into a huge, burning cartwheel.

One of the most tragic occurred to a young lieutenant—some of them have an almost impossible time adjusting. This one because he says he wouldn't have joined us except for undue influence. He had read of an F-101 pilot who had a much tougher emergency, even had to let down through an overcast, but had done a perfect job and saved a valuable aircraft. He says this is all he could think of when his control system went haywire. He says he really wanted to get out, but felt he had to try and bring it in. The bird nosed over on him at 200 feet on final. I don't know, I'm afraid there's going to be trouble if the guy he read about ever shows up around here.

There's one here—he's been around for years and is sort of an honorary leader—who contends that each time a new one of us shows up we only confirm his theory. It's quite simple, really. Never deviate from approved procedures is his Number One rule. He doesn't name names, but says many are here because they thought they had a better procedure than that worked out by the people who built the equipment and made the rules.

Next, he recommends that each pilot analyze his own limitations and capabilities. Better to land gear up beside the runway on the first pass than try to make a gear-down, single engine go-around and crash in the woods like he did, just because some stiff necked pilot taxied onto the runway.

Then he says that when you have trouble you can't afford the time to sit there and tremble; you've got to make up your mind ahead of time that you will do what has to be done. First you have to plan, then you have to act. He says we just don't have hardly anybody who quickly and correctly analyzed his emergency, then acted immediately. I get the feeling he is looking at me when he explains this part. I had the record for a while. I flamed out at 31,000 and punched out at 250. The other day though a couple guys came in who started at 39,000, let down through an overcast yet, then punched at ground level. Hard to beat that.

Oh well, as far as I'm concerned, being a ghost isn't so bad, once I got used to it. The worst part is not knowing what's going on. The guy in the back made it. I'm sure of that because he isn't around here. He stayed with me to 2000 and then went. He knew about that redhead in Memphis. I wonder. . . . ★

A LOOK

Over four years without an accident, 20,000 hours plus, of which over 16,000 have been logged in F-102 and F-106 aircraft, is the enviable record established by the 48 Fighter Interceptor Squadron, Langley AFB, Va.

We in the 48 FIS, are proud of the prolonged accident free operation we have had the good fortune to enjoy. However, we are not smug enough to say that "we have arrived" with a solution to accident prevention.

As one of the squadron's newer members, I cannot claim credit for this achievement. I do, however, sense the urgency, which permeates the entire organization, to extend the accident free record. The safety program was one of my first interests as a new commander. With the fine record that existed, I expected and found a determined application of all of the good operations and maintenance practices which are directed from higher authority. This is not to imply that everything was, or is now, "letter perfect." The struggle continues, as with all similar organizations I am sure, to implement new requirements and pick up discrepancies from those in effect before IG, Tac Eval or ORI catch them. Overall compliance was good and, I like to think, continues to improve.

More distinctive to me, as a new observer with more than a casual interest, was the squadron's attitude toward safety. This, I find, is much easier recognized than defined. A somewhat crude description might be that this "attitude" reflects achievement of the long stated intent of safety programs; namely, to identify, expose, and correct discrepancies to prevent accidents. The uninhibited support of this goal results in open and free discussions of emergencies, malfunctions, near accidents, etc. Although bouquets are not tossed to the guy who goofs just because he admits it, he is not censured, belittled or otherwise embarrassed. Consequently, the responsibility to share these experiences with fellow airmen outweighs any other consideration.

This is but one of the many desirable outcomes of a good attitude toward safety. There are so many areas in which sound operation is required in order to pro-

COLOMBIAN TROPHY AND USAF FLYING

The 48 Fighter Interceptor Squadron (ADC), Langley AFB, Virginia, has been awarded the Colombian Trophy for its outstanding safety record during 1961. Presented for the first time since 1940, the Colombian Trophy is awarded to a tactical unit determined to be the outstanding winner of an Air Force Flying Safety Award. The trophy was established by the Republic of Colombia in 1935, suspended in 1941, and renewed as an annual award beginning with 1961.

The safety award announcement also listed the following units as recipients of USAF Flying Safety awards for calendar year 1961:

5070 Defense Systems Evaluation Squadron
Elmendorf AFB, Alaska (AAC)

48 Fighter Interceptor Squadron
Langley AFB, Virginia (ADC)

482 Fighter Interceptor Squadron
Seymour Johnson AFB, North Carolina (ADC)

328 Fighter Wing
Richards-Gebaur AFB, Missouri (ADC)

478 Fighter Wing
Grand Forks AFB, North Dakota (ADC)

Rome Air Development Center
Griffiss AFB, New York (AFSC)

3510 Flying Training Wing
Randolph AFB, Texas (ATC)

58 Air Rescue Squadron
Wheelus AB, Libya (MATS)

15 Tactical Reconnaissance Squadron
Kadena AB, Okinawa (PACAF)

Det 1, 315 Air Division
Naha AB, Okinawa (PACAF)

6091 Reconnaissance Squadron
Yokota AB, Japan (PACAF)

314 Air Division
Osan AB, Korea (PACAF)

4 Air Division
Barksdale AFB, Louisiana (SAC)

AT SAFETY

vide safety that emphasis cannot be extended to all functions at all times. However, with a broad safety-conscious base and free exchange of ideas and experiences, proper "timing" of emphasis is facilitated.

Generally an organization is thought of in broad terms as equipment, facilities and personnel. Equipment includes aircraft and support equipment. The aircraft is comprised of many systems and the support gear is in many categories. Personnel and facilities may be reduced similarly for analysis. Ultimately a tremendous number of ingredients comprise a fighter squadron. When the *functions* of operations and maintenance are similarly diagrammed, it becomes apparent that continued emphasis to cover all contingencies in all areas is really impossible. Thus, the matter of "timing."

I believe that experienced supervision in operations and maintenance, through continued study and interest, cause emphasis on the right thing at the right time in the respective areas of responsibility. This minimizes potential hazards and incidents, and provides the required training and confidence to cope with those that do occur.

The 48 FIS is fortunate in having depth of experience among supervisors in both operations and maintenance. A large number have been in the squadron for several years. They have worked and flown together for a long time. In the process, they have developed a good knowledge of each others' capabilities and limitations. This, I feel, enhances efficiency and safety.

The factors which I have identified as prime in the 48 FIS accident prevention then are: "attitude," "timing," and "depth of experience" in key supervisory positions. There are many others including plain good fortune. We hope for future abundance of each. ★

Lt Col Jimmy J. Jumper, Commdr, 48 Fighter Interceptor Sq., (ADC), Langley AFB, Virginia

SAFETY AWARDS . . .

4050 Air Refueling Wing
Westover AFB, Massachusetts (SAC)

819 Air Division
Dyess AFB, Texas (SAC)

55 Strategic Reconnaissance Wing
Forbes AFB, Kansas (SAC)

314 Troop Carrier Wing
Sewart AFB, Tennessee (TAC)

170 Tactical Fighter Squadron
Capitol Aprt., Springfield, Illinois (TAC)

20 Tactical Fighter Wing
RAF, Wethersfield, England (USAFE)

49 Tactical Fighter Wing
Spangdahlem AB, Germany (USAFE)

146 Fighter Interceptor Squadron
Greater Pittsburgh Aprt, Coraopolis, Pa (ANG)

127 Tactical Fighter Squadron
McConnell AFB, Kansas (ANG)

96 Troop Carrier Squadron
Minneapolis-St. Paul Intl Aprt
St Paul 11, Minnesota (CONAC)

434 Troop Carrier Wing
Bakalar AFB, Columbus, Indiana (CONAC)

SKYBOLT

Excerpts From Engineering Paper No. 1309 by Douglas Aircraft Company

The Skybolt, the first ballistic missile to be fired from a flying platform, will soon enter the Air Force operational weapon system inventory. One of the most important considerations in the design of the entire missile system has been that of safety design engineering to protect operator, maintenance and other support personnel and to avoid damage to equipment which might lead to personnel accidents or degraded system effectiveness.

The Skybolt weapon system is composed of an air to surface ballistic missile, airborne and aerospace ground support equipment, the personnel subsystem and support facilities and logistics. The missile includes two solid propellant engines which fire in sequence after the vehicle is launched from a B-52. Four missiles are carried aboard the aircraft, two tucked under each wing. The missiles are drop launched from specially designed pylons. After launch, the first stage engine ignites and the missile is programmed into a ballistic trajectory. Following termination of the boost phase of the second stage the atomic warhead continues alone along the ballistic arc.

At the Douglas Aircraft Company, prime contractor for the Skybolt, the design of safety factors receives a great deal of attention from the very inception of pre-proposal studies and proposal effort and continues throughout the life of the R&D and operational programs. Each design engineer has responsibility for the safety design of his equipment. To assist his effort, a battery of subject matter experts is utilized for consultation and for engineering design review. These experts include human factors specialists, bio-scientists, reliability specialists, safety specialists, field service personnel, and other technical area specialists. The vast technical capability and experience of Air Force and other military and industry personnel are utilized wherever applicable.

The design of the Skybolt system for safety follows two parallel paths. The first concerns the planned operational utilization of the missile system. This involves handling, checkout, maintenance, loading, and launch operations of the missile and support equipment and includes equipment safety. The second approach includes the detailed analysis of personnel safety specifically to assure that as many potential causes of hazards to Skybolt personnel are removed in the design stage as possible, compatible with mission accomplishment. Both approaches contribute significantly to the safe handling and operation of this vital missile system.

These analytical approaches obviously cannot be completely described and examples of each presented in this article. They cover Systems Analysis, Personnel-Equipment Data, Human Engineering, Field Test, Airborne Safety, and Safety Design for Support Operations. Two examples taken from the Human Engineering and Airborne Safety areas will give an idea of the thoroughness of safety analysis.

The first approach to Human Factors design for Skybolt safety was the preparation of detailed human engineering design criteria. These design requirements have been developed to provide design guidance to the engineers to facilitate the tasks of operator, maintenance, and other support personnel as well as the design for personnel and equipment safety. Both design criteria and design checklists have been prepared; the former provide design requirements, the latter provide feedback on the effectiveness of the engineer's efforts. A typical page from the Safety Design Criteria Section of the Human Engineering Manual for Skybolt is shown in Figure One.

An analysis was made of the critical factors affecting the safe aircraft carry and launch of the Skybolt. A case in point is the design of the airborne equipment to safeguard against the inadvertent release or jettison of the missile due to system failures, malfunctions, acts of nature, or any other conceivable occurrence. To test the effectiveness of this design, a comprehensive study was made of the safety requirements involved in aircraft carry of the Skybolt missile. Every possible means of inadvertent missile engine firing or unintentional missile jettison was rigorously analyzed. Results of the study proved that the likelihood of unintentional missile release is so remote as to be considered non-existent.

In this study, the possible causes that might lead to four major types of malfunctions were studied to determine the possibility of unintentional release of the missile from the aircraft. These malfunctions include:

1. Inadvertent first stage ignition
2. Inadvertent second stage ignition
3. Inadvertent stage to stage separation
4. Inadvertent reentry vehicle separation

In assessing the efficiency of the design for preventing any of these malfunctions from occurring, the following conclusions were drawn:

1. The possibility of electrical failures which can lead to any of the malfunctions described above is completely eliminated by means of a rigorous sequencing procedure. Ignition or staging signals can only occur after the missile battery is activated. To activate the battery, two separate commands are required from the launch control panel aboard the aircraft. Then, to permit ignition and staging commands to reach the safing and arming mechanisms, the missile separation switch

Figure One

SAFETY DESIGN CRITERIA

8.1 *Hazards and Safety.* As a part of ground equipment design, safety factors are of primary importance. The following safety considerations shall be applied. Space precludes a complete listing of all considerations; however, it is up to the design section to apply all safety principles.

8.1.1 Ensure that conspicuous placards are mounted adjacent to high voltage, extremely cold, very hot, etc., equipment.

8.1.2 Operations of switches or controls which initiate hazardous operations, such as ignition, crane moving, etc., shall require the prior operation of a related or locking control. Where practicable, the critical position of such controls shall activate a warning device in the affected area.

8.1.3 A hazard alerting device shall be provided to warn personnel of impending or existing hazards (i.e., fire, presence of combustible or asphyxiating gas, radiation, etc.).

8.1.4 Provide a guard on all moving parts of machinery and transmission equipment, including pulleys, belts, gears, and blades, etc., in which personnel may become injured or entangled.

8.1.5 Incorporate self-locking or other safety devices on elevating stands and work platforms to prevent accidental or inadvertent collapse.

8.1.6 Employ some form of anchor or outriggers on stands with high centers of gravity.

8.1.7 Provide handrails on platforms, stairs, and around floor openings or wherever personnel may fall from elevation.

8.1.8 Attach a safety bar or chain across stair or step openings on a platform to prevent falling.

8.1.9 Incorporate "No Step" markings where applicable.

8.1.10 Indicate the weight capacity on stands, hoists, lifts, jacks, and similar weight bearing equipment to prevent overloading.

8.1.11 Jacking and hoisting points shall be conspicuously and unambiguously identified.

8.1.12 Provide skid proof flooring and stair or step treads.

8.1.13 Allow clearance for fingers in the design of telescoping steps or ladders.

must be activated by physical separation of the missile from the pylon.

2. Even after the missile separation switch has been activated, it is still necessary to pull the lanyards from the safety and arming devices before ignition or staging can occur. Each lanyard requires a pull in excess of 150 pounds, thereby greatly reducing the possibility of removal by action other than separation of missile from pylon.

3. The safing and arming devices add another safety feature since both electrical and mechanical alignment are required for proper operation. In the safe condition, an out-of-alignment situation exists, causing the flame charge and separation igniter circuits to be shunted and a valve to be locked across the flame tube ports. A squib is used in the safing and arming device for both engine ignition and stage separation. This squib can only be fired inadvertently by excessive voltage, but still no ignition would result due to the misaligned safing and arming device. In the case of accidental firing of the igniter flame, a by-pass plug allows the ignition flame to be harmlessly vented.

By the time the Skybolt Weapon System reaches the Air Force operational inventory in 1964, it will have been well wrung out with respect to safety design and procedures to protect the operator and maintenance personnel and to avoid damage to equipment. To complete the system approach for the design of safety, the effort can only be considered to be completed after two additional steps have been accomplished by the using command. The first of these is the administration of proficiency tests to operator, handling, and maintenance personnel and others responsible for safety. Among other objectives, these tests which are currently under development for the Skybolt System will evaluate the safety knowledge and awareness of operational personnel. Where knowledge deficiencies exist, training and technical manual review should bring the personnel involved up to an acceptable level.

The second step that must be completed in the operational environment is to report any potential safety hazards which may still exist after the exhaustive design effort has been completed. Operational personnel and technical field representatives can close the final loop back to engineering design by proper and effective reporting procedures. Product improvement design effort will be initiated as required.

Although the design engineer and his various design consultants have paid and will continue to pay a great deal of attention to safety design and safe procedures requirements, in the final analysis, the operational personnel can assist in the achieving of ultimate human and equipment safety on the Skybolt and any other weapon system by thinking and practicing safety at all times. The design team is doing an excellent job of eliminating hazards at the design level, but it is still the ultimate responsibility of the user to avoid human errors which might result in personnel injury and/or equipment damage. The Skybolt Weapon System adds tremendous striking power; the Air Force personnel can help meet the design objectives by using it safely and effectively. ★

• • •

VAGUE ON VOR

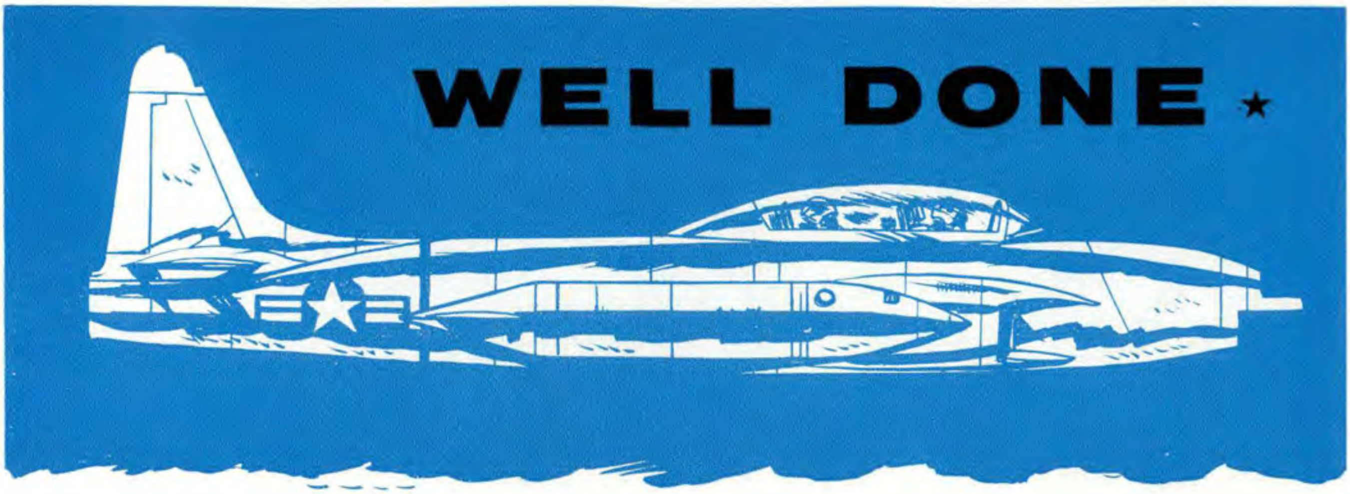
In the first paragraph of the article "Vague on VOR" (March 1962), we gave three reasons for reprinting it: first, several accidents disclosed that pilots were not aware that the ID-249 is usable in the event of AC power failure; response after the article first appeared indicated that this type of information was well received, and instrument schools might want to use this information in their curriculums. After this paragraph we reprinted the article. Unfortunately, it could then be interpreted that the whole article dealt with omni operations without AC power.

As one of many writers noticed, when AC power is lost the ID-249 is usable, however only the CDI, To-From and Course Selector. Our apologies for having presented misleading information. We appreciate the careful reading by many and their interest in correct information—even the writer who explained that a "track" is what a train runs on and "needles" are to sew with.

PROFESSIONALISM KEYNOTE OF ANG SAFETY MEETING

Professionalism is the theme of the Air National Guard Flight Safety and Commanders' Conference, April 26-27, at McGhee-Tyson Airport, Knoxville, Tennessee. Purpose of the conference: to explore all possible avenues for further safeguarding of lives and property, and to present ANG commanders with information concerning the current and future ANG programs.

Conference highlights include keynote addresses by Major General Perry B. Griffith, Deputy Inspector General for Safety, and Major General Winston P. Wilson, Asst. Chief, National Guard Bureau, AIR.



★ *Captain John S. Rumph*

9th Bombardment Wing, Mountain Home AFB, Idaho

Captain John S. Rumph was flying an emergency personnel transport mission from Hill AFB to Amarillo AFB in a 9th Bombardment Wing T-33. After receiving clearance to descend to 21,000 from 38,000 feet, power was reduced to 80 per cent. As the aircraft descended through 36,000 feet, severe engine vibrations occurred. Engine instrument indications were observed to be in normal operating range. As the descent was continued the vibrations increased in severity. An emergency was declared with Albuquerque Center. Just prior to reaching 21,000 feet, while in the overcast, Capt Rumph noted sparks in the area of the forward right console. Immediately following this all cockpit lights went out and strong electrical fire type fumes were noted. With the aid of a flashlight Captain Rumph saw that the warning light and instrument light circuit breakers were popped. He made an attempt to close the circuit breakers, but when sparks and fumes again resulted the circuit breakers were left open.

The entire descent was made under night, weather, emergency conditions with the aid of a flashlight and steers from FAA and GCI radar.

During the latter portion of the flight engine vibrations continued to increase in severity to the point that reading of the instruments was extremely difficult, particularly on final approach. After landing on downwind runway to expedite, Capt Rumph shut down the engine and evacuated the aircraft.

Ejection was considered during flight; however, due to the night weather conditions and the aircraft being in the vicinity of the populous areas of Amarillo, Texas, this course of action was decided against.

Captain Rumph's professional handling of this emergency saved the Air Force one T-33 and possible damage to civilian property had the decision been made to eject. This pilot's accomplishment reflects great credit upon the United States Air Force and is exemplary to all other Air Force crewmembers.

WELL DONE! ★

Safety men know it's an uphill pull to get a downhill curve on the accident chart.

Airman lost control of vehicle on curve at high speed, resulting in demolished car and airman's death.

Lieutenant killed when auto he was driving skidded into oncoming traffic and collided with another vehicle.

MSgt lost control of car at high speed and crashed into a tree near the highway. Two fatalities.

These are examples of automobile accidents that took 76 Air Force lives during the first three months of this year.

Everywhere safety men are searching for ways to reduce the number of motor vehicle accidents, the Air Force's—and the nation's—biggest killer. Here's what they're doing at Dyess AFB. Perhaps there are some ideas that may help cut the rate of other Air Force bases.

Young drivers—under 25—are required to attend a ten-hour driver improvement training course under AFR 32-17. In addition, the base has a driver's remedial training course which is given to persons demonstrating poor driving techniques, to personnel receiving certain types of traffic citations, as well as to many of those involved in accidents.

The program was set up to eliminate, if possible, and at least to minimize, the number of accidents, violations and injuries and the amount of property damage. A review of traffic problems indicated that excessive speed, intoxication, fatigue and disregard for good safety practices were responsible for most vehicle accidents. The two training courses were designed to emphasize these factors and to indoctrinate people with safe driving practices.

Then a base traffic safety review panel was established consisting of representatives of organizations concerned with traffic safety. Cooperation was obtained with state, county and city traffic authorities. The review panel meets, as necessary, to consider traffic problems and to review actions taken as the result of accidents or when citations are issued to violators. When personnel of the base are issued traffic tickets by civil authorities, the base is immediately notified.

Here are some examples of action taken at one meeting:

- Civil police had cited an airman for driving 95 mph in a 60 mph zone and for imprudent driving. The offender was fined a total of $120 and spent one day in jail. Then he was interviewed along with his supervisor by the base commander. As a result he had his private driving privileges suspended for the duration of his assignment at Dyess and was restricted to the base for 14 days. After considering all aspects of the case the panel considered the punishment adequate and made no further recommendation.

- Another man cited by military police for speeding 35 mph in a 25 mph zone received a verbal reprimand and suspension of driving privileges on base for 90 days. In this case the panel recommended the offender attend the remedial training school.

- A driver was cited and heavily fined by civil authorities for excessive noise due to inadequate mufflers on his car. He also was cited by base police and received a verbal reprimand. The panel considered the punishment adequate.

- A SSgt was cited both by base police and civil authorities for speeding and driving while intoxicated. In addition to civil action, the panel recommended suspension of the man's driving privilege for six months and attendance at the remedial driver training.

From the foregoing it is apparent that the panel considers the cases on their merits and makes recommendations aimed at prevention of accidents. Personnel guilty of serious offenses receive no mercy; minor offenders receive at least a verbal reprimand and if circumstances warrant may be required to attend remedial training. Members of the panel feel that remedial training for minor offenders is one of the best weapons for preventing more serious accidents.

One of the important factors is cooperation between base authorities

and civilian agencies. A man may be cited 100 miles from the base by a state highway patrolman. Without close military-civil cooperation the base authorities may never know of the incident and a habitual offender or dangerous driver might never be detected. Now you know, if you are stationed at Dyess, that distance from the base does not mean that you can keep driving offenses quiet.

Lieutenant Colonel Troey Daffern, director of safety, 96th Bomb Wing, feels strongly that the program, including the review panel, has done much to improve traffic safety at Dyess and cut down on the number of accidents involving base personnel.

He is also a believer in the use of safety belts. If your car is parked on base and you don't have safety belts, chances are that one of these days you'll find a small slip of paper under the windshield wiper or on the seat which reads as follows:

"We noticed that you do not have safety seat belts installed in your car. Did you know that in the last six military private motor vehicle accidents, if the subject airmen had had seat belts on they would not have received disabling injuries? See about obtaining them (belts) since the price is so low. Remember, the life you save might be your own. For further information contact the wing safety office."

In a recent fatal accident it was determined that had the airman been wearing a seat belt he would have survived.

Driver safety is not the only area of interest. Every year hunters are killed when rifles and shotguns are accidentally fired. If you want to borrow a hunting weapon at Dyess you first report to the safety office and receive a short indoctrination on the use and care of firearms. Then you get the weapon. To date there have been no hunting injuries from firearms.

Another item is the use of 15 AF Form 316 SAFETY MEMO. This is a small (4x6 in.) piece of paper used to point out hazardous conditions and practices. These are issued to commanders, supervisors and safety personnel. When one of these people detects a hazard he whips out his pad of forms and writes up the hazard something like a cop issuing a ticket. One copy is left with the offender, one goes to the safety office and a third is kept by the issuer. The offender is expected to correct the hazard immediately, if possible, and report to the squadron safety officer within 24 hours.

These are some of the weapons one base uses in the constant battle to reduce the number of deaths and injuries resulting from accidents, or those mishaps labeled accidents for want of a better descriptive term. But the best program that man can devise canot work unless individuals make it work. Perhaps the following expresses this idea well:

Here lies the body of Jonathan Jay,
Who died maintaining his right-of-way.
He was right, dead right, as he sped along,
But he's just as dead as if he were wrong. ★

• • •

BY GEORGE!...

That Was a Close One. In poring through the masses of TWXs that are received daily, one thing sticks out in bold relief: there's often just a small margin between a seemingly trifling incident and a major accident. Often this small difference is the only factor between a damaged airplane and a major catastrophe. Sometimes a life is lost or saved by a mere fraction. Anyway, here is one of these instances related for your benefit. If you have one of your own, send it along to Rex. If you don't want your name used, it won't be—but please sign your letters.

Down Low. Two F-86Hs were blowing and going on a low level mission. While circling at 300 feet trying to confirm a checkpoint, the lead pilot dropped his map. With his head in the cockpit the pilot tried to find his map, entered a dive and knocked down some power lines during the dive recovery. He made it back to home plate OK but the 'H model was bent up some.

Rex Riley

BIRD TIPS

A T-33 accident happened when a component of the external fuel tank jettisoning system malfunctioned. The aircraft had accelerated to lift-off speed when one external fuel tank jettisoned. The pilot, despite heroic effort, could not keep the aircraft on the runway. The weight of the remaining tank and fuel caused the wing to drop. The tank dragged along the ground and ruptured. Spilled fuel was ignited by sparks and a frightening conflagration broke out about and on the airplane. The rear seat occupant, a non-pilot type, apparently panicked and activated his ejection mechanism after the aircraft had stopped. He died from his injuries.

Investigation showed the tiptank jettison system activated because the plastic in the jettison button had deteriorated and broken. A circuit was completed and electrical current directed to the jettison solenoids. Fire damage made it impossible to determine *why* one tank failed to jettison.

The pilot's testimony revealed he was not thoroughly familiar with the auto-drop system. Although it was not determined to be a factor, the auto-drop switches were not positioned as required by T. O. 1T-33A-1.

The circumstances surrounding this regrettable accident resulted in a searching study of Dash One procedure and a look at the cockpit switches of the auto-drop system. The instructions in the Dash One were adequate but shrouded in excess verbiage, making an otherwise simple procedure difficult to understand. A look at the controlling switches in the cockpit showed the one labeled "ARM, OFF, AUTO" to be neatly decaled, above the switch, with one word: "INOP."

The prime AMA was very prompt and issued a flight safety supplement after being made aware of this condition. In clear concise language the function of the auto-drop system was explained and the procedure for its use was spelled out. T. O. 1T-33A-SF-1-9 was issued 29 September 1961—ITEM CLOSED!!

So a few months later a T-Bird was taxiing to take off. When the pilots placed the auto-drop switches to appropriate positions—the external fuel tanks fell from the wingtips and ruptured upon the ground. Another day and another T-Bird was parked, just prior to taxiing for takeoff. The pilots placed the auto-drop switches to appropriate positions—the external fuel tanks fell from the wingtips to the ground.

The investigation of the two incidents, which happened to different T-Birds on different dates in different parts of the world, showed them to have been frequently flown with discrepancies which would have caused the tiptanks to fall off had the auto-drop switches been positioned as required by T. O. 1T-33A-1. It doesn't take a person with the deductive reasoning of a "Holmes" to conclude that jocks were not using the auto-drop system. *A question does arise:* Do they *know* the systems and are just negligent, or are they ignorant of the inner workings of the machine they're flying? Which?

Ere long the last surviving T-Bird will be accepted by the curator at Wright-Pat. Wonder how many will be scratched before then because some one, either through negligence or ignorance, failed to follow procedures? ★

• • •

Not particularly significant but an item of interest is the number of T-33 major accidents which occurred years '50 through '61 inclusive: TWO THOUSAND ONE HUNDRED SIXTY—a lot of bashes you jocks just gotta admit.

Here's how they break down by numbers and rate each year:

Year	50	51	52	53	54	55	56	57	58	59	60	61
Bashes	22	64	152	286	311	340	294	244	164	132	73	78
Rate	—	54	42	35	27	27	21	19	12	9.4	4.7	6.7

As we go to print the figure stands at TWO THOUSAND ONE HUNDRED SIXTY-FIVE. Don't you be number 2166. ★

"YOUR CHECKLIST—The Nucleus of Nuclear Safety" was the winner among 1000 entries in the Nuclear Safety Slogan Contest conducted Air Force-wide by the Directorate of Nuclear Safety, Kirtland AFB, New Mexico. First prize was won by Captain Lucien D. Wise, NSO, of Hq TAC, Langley AFB, Virginia. Pictured, l-r: Captain Wise receives commendation from General Walter C. Sweeney, Jr., TAC Commander, and Major General Perry B. Griffith, Deputy Inspector General for Safety, Norton AFB, Calif.

Second prize was won by TSgt Robert B. Carothers, 78 A&E Sq, Hamilton AFB, Calif. His entry was: "Nuclear Safety is an Investment with Interest—Yours!"

Honorable mention was given SSgt Joseph Campbell, 22 Civil Engineering Sq, March AFB, Calif., Major W. W. Carmichael, Hq Sq Sec, 68 CSGP (SAC), Chennault AFB, La., and A1C Julius C. Larson, 42 MMS, Dyess AFB, Texas. ★

RAT LEVER . . . Here's some info received recently from Republic Aviation Corporation that I'd like to pass on to you pilots flying the '105. It was learned recently that if the flight controls are moving while the RAT lever is being moved, the lever may bind at mid travel and result in locked flight controls. A new Safety of Flight Supplement instructs:

"No flight control movement during RAT lever movement."

The fix for this item is a pressure relief valve set at 500 psi in the Pl return line. Republic is installing this in production aircraft. Retrofit kits are being shipped to the various bases operating the '5. This pressure relief valve will eliminate the locked stick condition. On the unmodified aircraft, if the RAT lever binds at mid travel, it should be forced to the EXTEND position or else returned to the RETRACT position. The RAT lever should *not* be allowed to remain in an intermediate position.

Major Donald G. Page, Tactical Branch, Fighter Div.

CENTURY NOTES

CENTURY NOTES

COMPOUNDING THE ODDS . . . The stage was really set up for this F-106 mishap. A number of things went wrong at the right time. None of these malfunctions in themselves would have caused a serious incident, but when they were put together in the same aircraft at the same time with the help of the pilot and an improperly rigged barrier, the odds were in favor of crumpling the "Six."

It all started when AC/DC power failed during a routine training mission. The emergency AC power came on the line as it should and all attempts to reset the normal generators were unsuccessful. The aircraft was slowed to 250 KIAS and the pilot started back to the base. A chase aircraft had joined up to escort the sick six back to the base. Fine! Everything according to the book! AC power failure! OK, let's get it on the ground, nose high—hold down the maneuvering, make a straight in. No sweat!

That's right, no sweat, plenty of fuel, no weather to speak of, 10,000 feet of dry runway, tailhook, drag chute, and a barrier. A piece of cake. So let's see how to work this one into a not-so-routine emergency. The pilot called his chase and stated that he would turn his master switch OFF then ON in an attempt to clear any hung relays (not an emergency procedure). When he did this, complete electrical failure occurred. Now he was unable to get the emergency AC and transformer/rectifier back on the line. Why? *The emergency battery was dead.* No source of DC power to operate the relays. Now we have a compound emergency. The landing gear was lowered with the emergency system and a straight-in approach was made. Touchdown was slightly hot approximately 1800 feet down the runway. Braking seemed ineffective. The pilot had no speed brakes, drag chute, tail hook or idle thrust decay available. So he took the barrier. But one side of the barrier chain had not been connected to the engagement cable and the aircraft veered to the right. Fortunately the barrier cable caught on the left gear scissor bolt which effected positive engagement and the aircraft came to a stop with minor damage. Lucky? I guess! Of course, the pilot did not know the condition of the battery or the barrier. By turning the master switch off, he compounded the electrical failure and thereby lost his auxiliary stopping devices.

A thorough knowledge of the F-106 electrical system is mandatory for the drivers. Maintenance personnel should take a close look at their procedures for emergency battery care. That little battery means a whole lot in a bind. Obviously, barriers must be properly rigged at all times. Enough said. ★

Captain M. O. Detlie, Defense Branch, Fighter Div.

RADAR HAIL AND STORM AVOIDANCE

Courtesy: The MATS Flyer

Hail damage to two Air Force aircraft in January again illustrated that this hazard is still with us. During the thunderstorm season, it can be expected to become more prevalent.

There is reason to believe that, in most instances, hail can be avoided with radar equipped aircraft if proper precautions are taken. The following article, which first appeared in 1959, points out that United Air Lines had never experienced a hail damage incident to an aircraft equipped with operating radar. A recheck before press time disclosed that they have continued to maintain this perfect record. When asked what refinements have been made that should be incorporated in the article before reprinting, the reply was, "Don't change a word. Information in the article is identical to that being emphasized today." The only additional suggestions were to use about one degree of down tilt at jet altitudes (35,000 feet) and to turn the radar set on soon enough to get a picture of what's ahead in ample time to take action.

Is hail avoidance possible?

United Air Lines has never had a radar-equipped aircraft damaged by hail.

How is hail avoidance accomplished?

By proper operation of radar.

By knowledge of echo interpretation on the scope.

By always following avoidance techniques.

• *RADAR OPERATION*

The key to successful use of radar is operation of the gain control. Follow this procedure:

Turn the gain up until static (noise) return is received, (if on the ground run antenna tilt up to eliminate ground clutter) then back off the gain to the point where the static just disappears. ALWAYS USE THIS STANDARD MAXIMUM GAIN SETTING.

To set the gain properly the knob should be turned clockwise until the scope is covered with the heavy yellow, salt-like noise return (A of Fig. 1). The knob should then be slowly turned counterclockwise until the noise return just disappears or, to be reasonably certain it has not been turned too low, until a very faint trace of salty flecks of noise return still remains (B of Fig. 1). A bare trace of noise return will allow the set to see all targets without objectionable interference, and just as important, will permit the operator to view storms, year in and year out, with the same receiver sensitivity. In most sets, the gain setting will be approximately between the ¾ and ⅞ clockwise position. As the tubes deteriorate, this setting will be slightly higher.

If this procedure for setting gain is used, year in and year out—as it should be—the operator will see a standard return and will be able to evaluate storms against past experience.

Other adjustments should be made as per operating instructions for the set concerned, but the standard maximum gain should never be adjusted, once set. When range settings are changed it may be necessary to ad-

Figure 1A. Gain too high.

Figure 1B. Proper gain setting.

Figure 2A. Tilt too low.

High Gain.

Low Gain.

A (sharp gradient)
B (weak gradient)

U-shaped echos are rough.

Minimum corridor width below freezing level (10 miles).

Without Iso-Echo (Note hail finger)

With Iso-Echo (Note hail finger)

just brightness, BUT NOT GAIN.

Tilt setting, too, is important for weather interpretation. There is no good rule of thumb guide for proper tilt setting because proper tilt setting will change with altitude and range used. Think of your radar as a flashlight; you must direct the beam at the object you wish to see. At ranges in the neighborhood of 15 to 20 miles, a zero tilt setting should insure good readability at any altitude, but at ranges of 150 to 200 miles at an altitude of 15,000 to 18,000 feet this setting would be too high. This is due to the curvature of the earth's surface.

There are a few "tricks of the trade." One very useful item for setting proper tilt is the so-called ground clutter. For example, if we are using the 150 to 200 mile range, we can adjust the tilt until ground targets just begin to appear at the distance desired. We can now be certain that the bottom portion of the beam has just touched the ground and its natural spread upward will take care of any storm in the vicinity. Storms located in the midst of mountain peaks are best observed by permitting just a few of the higher peaks to remain on the scope. See Figure 2 A,B,C for this. This again assures us that we are not looking too high and observing the weaker portion of the storm or, more important, the ice crystalline portion, in which case the storm may appear more innocent than it really is. A few "dry runs" on days when there are no storms to observe will prove invaluable in learning about proper tilt setting.

Occasionally, when flying around thunderstorms, it may be desirable to run the tilt up momentarily to obtain an estimate of what is going on at higher levels.

Figure 2B. Tilt could be too high. (No ground clutter reference.)

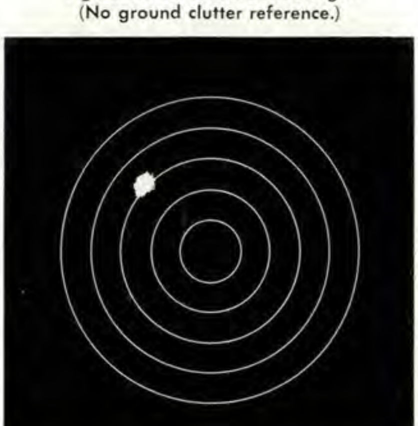
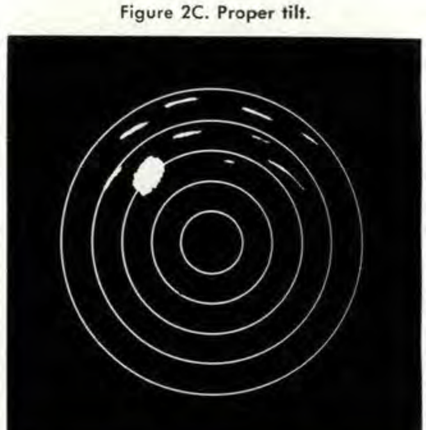


Figure 2C. Proper tilt.



• ECHO INTERPRETATION

Your radar when used for weather observation can only tell you where moisture concentrations (in liquid form) are located. If the moisture concentration happens to be in crystal form (ice) it experiences some difficulty in giving you the "whole" picture and that is why there are different detouring distances when operating above the freezing level. It is by studying these concentrations to determine their gradient or shape and then assigning the proper detour distance that United has been able to avoid hail damage to their fleet of RADAR-equipped planes for a period approaching six years.

• TURBULENCE

Turbulence is caused by shear. Shear occurs when windflow in adjacent areas varies in direction or

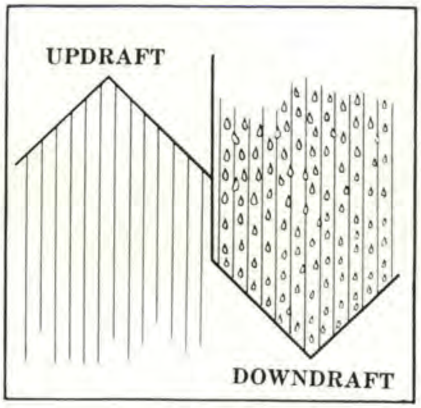


Figure 3.

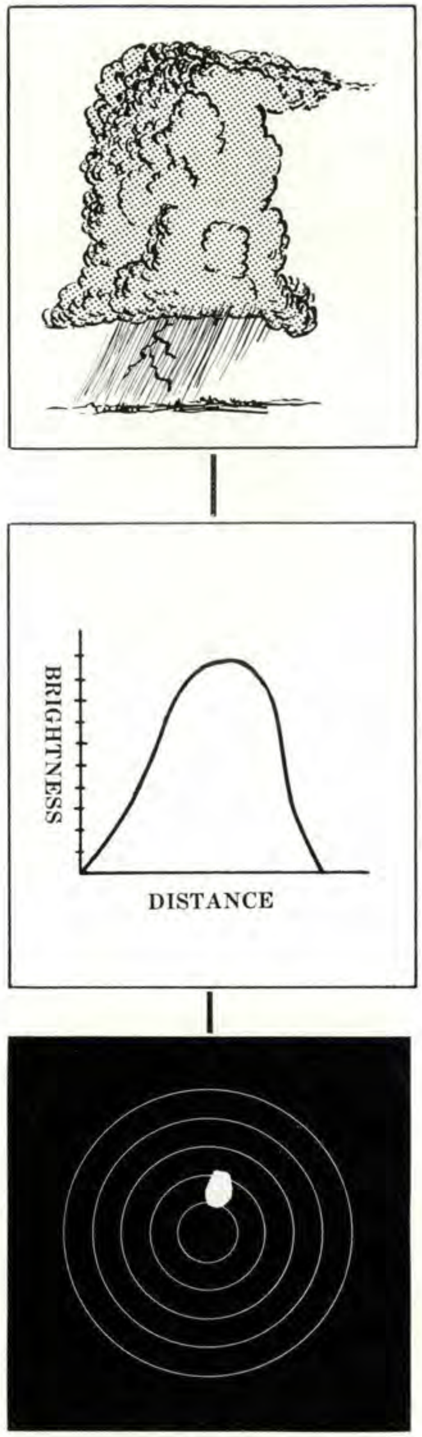


Figure 4.

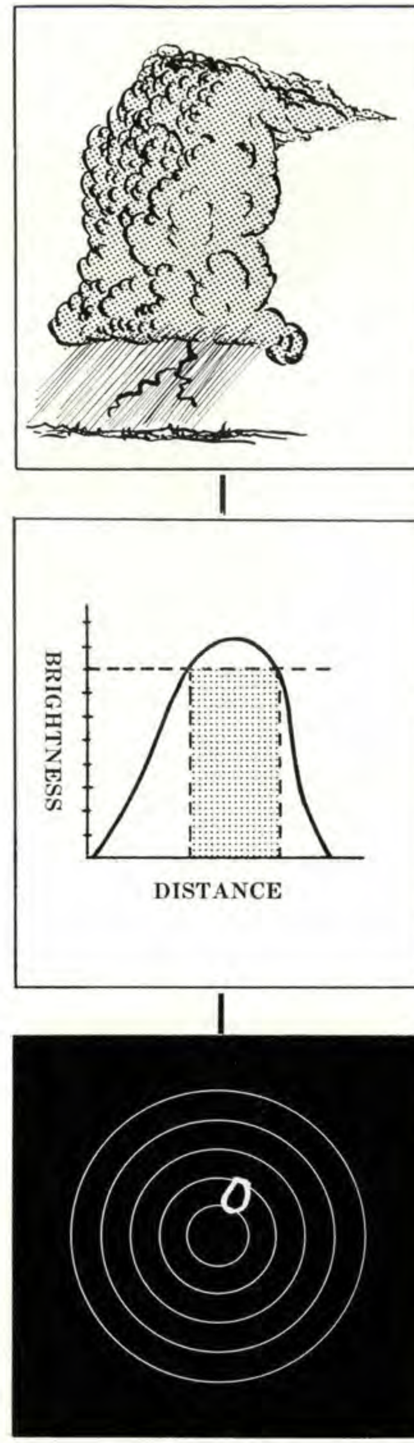


Figure 5.

speed, or both. The degree of turbulence is proportionate to difference in windflow speed, angular change of flow direction, or both. Turbulence is extreme in thunderstorms because vertical currents of air are flowing in opposite directions at high rates of speed. Schematically, these updrafts and water-loaded downdrafts are shown in Figure 3.

The degree of turbulence encountered during flight through any such area of shear is dependent upon two things—how fast the aircraft passes through the shear zone and how sharply defined the shear zone is. To a degree, the pilot has some control over this by slowing down when storms are penetrated. With a RADAR-equipped airplane, this slight control is not nearly as effective as picking an area of more gradual shear gradient or by simply assigning a proper detour distance and avoiding the area entirely.

RADAR enables a pilot to "see" shear and avoid areas of maximum shear (turbulence). If his set is equipped with contouring circuitry (iso-echo), he chooses a flight path through areas of most gradual shear gradient, or avoids it entirely.

Since RADAR echoes shown on the scope indicate moisture content, this can be pictured as in Figure 4.

Contouring circuitry (iso-echo) blanks out returns above a fixed degree of brightness. With this feature the storm echo depicted in Figure 4 would appear as shown in Figure 5. Frequently two storms that appear approximately equal in size and intensity without contouring (iso-echo) (Figure 6) are found to be of considerably different intensity when viewed with iso-echo (Figure 7).

Immediately, we know that storm B has sharp shear and heavy turbulence.

Actually, were we to fly through storm A we would probably encounter conditions as in Figure 8.

In storm B (Figure 6 and Figure 7), however, the gradient is much sharper; therefore, this storm should be avoided by the proper distance or, if you must get closer, slow down.

Well, this isn't really as complicated as it sounds. Just remember this. With a RADAR-equipped aircraft with contour circuitry (iso-echo) the most severe turbulence would be pictured as a thin circle of light. We should also now be sus-

Figure 6. Without Iso-Echo.

Figure 7. With Iso-Echo.

Figure 8.

Figure 9A. With Iso-Echo.

picious of echoes which have well-defined edges. Both of these are examples of sharp shear.

Is there any way comparative severity of storms can be determined without contour (iso-echo)? Yes, to some degree. By decreasing gain on the set, the targets will grow smaller. Iso-echo cuts out the intense precipitation core. Turning down the gain leaves only the intense precipitation core. Also, turning down the gain eliminates weak echo and unmasks fingers and other signifigant shapes that indicate most severe turbulence and/or hail. Those which decrease the most are the least intense (have less shear). This gives an approximation of iso-echo, as illustrated in Figure 9 A, B, C.

Iso-echo is the ideal device for storm interpretation, but intelligent use of low gain affords a good substitute on occasions when all storms cannot be circumnavigated.

If the "low gain" technique is practiced, the following procedure is suggested:

Mark the normal gain setting in order to return to this exact setting. Decrease gain to obtain some target fade and mark this setting. (Figure 10). Anytime a check is made for storm intensity TEMPORARILY decrease the gain control to the exact low-setting mark, then ALWAYS return it to the normal gain setting mark. In this way, the comparative pictures will always be in the same relative proportion. Any other setting will give the operator a non-comparative presentation of storm intensity.

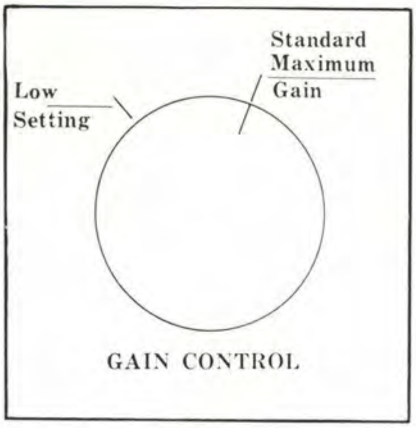


Figure 10.

There are fancier ways of doing this but this offers a method with a minimum of adjustment in the cockpit and as long as the operator keeps the two gain settings constant he soon will recognize the difference between various storms and make the proper flight correction.

• HAIL

The United Air Lines' procedure for RADAR identification of probable hail is to watch for, identify and avoid the following echo patterns:

- Pointing fingers
- Hooked fingers
- Scalloped edges

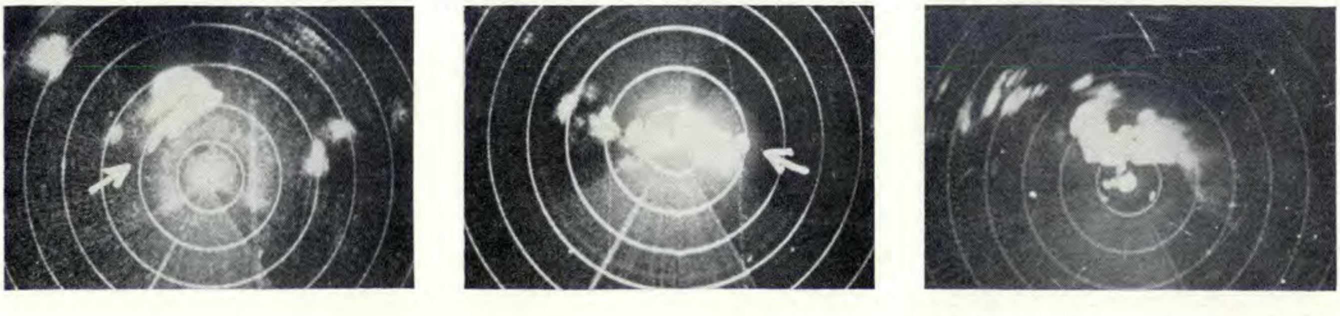
Watching for hail patterns:

Hail shafts appear to form quickly in active thunderstorms and constant scope monitoring is mandatory during flight near such storms. Any time a storm is changing shape fairly

Figure 9B. Without Iso-Echo.

Figure 9C. Low gain.

Figure 11, left, pointing finger; center, hooked finger (hail and possible tornado); right, scalloped edges.



RADAR HAIL . . .

rapidly, chances of hail shafts are excellent, and severe turbulence is almost assured.

Identification:

Figure 11 shows scope presentations of hooked fingers, pointing fingers and scalloped edges; all typical of hail shaft echoes.

Avoidance:

Shafts of hail characteristically fall from the fringes of thunderstorms rather than from the inner heavy rain core. Winds often carry these hail shafts well out into clear areas adjacent to the storm. In the Severe Weather Warning Center's hail summary, it was pointed out that hail encounters below 10,000 feet were predominantly within two miles or less of the storm. Between 10,000 and 20,000 feet, hail encounters ranged up to six miles from the storm.

United's procedure is to avoid all echo and heavy turbulence type returns by five miles or more below the freezing level and 10 miles or more above the freezing level. By utilizing the five-mile range markers on their scopes, they have evolved a simple procedure for measuring these distances. Below the freezing level they must be able to fly the inner circle between the storms, and above the freezing level they must be able to push the second circle between the storms. (Figure 12).

(Note: Anytime a "Figure 6" echo is noted it should be given wide berth as there is evidence to indicate that this echo pattern is sometimes representative of tornadoes. United admitted that sometimes what they call "hooks" could easily be classified as Figure "6's". Moral: Keep away from them.)

USAF ADOPTS DISCRETE FREQUENCY PLAN FOR ATC

Air Force air traffic control facilities throughout the CONUS will begin operating under the UHF discrete frequency assignment plan. At press time the effective time and date were 0500 EDT, Thursday, 3 May. Clear-channel discrete UHF freqencies will be assigned to the following ATC functions: control tower, approach control (conventional RAPCON, departure control (RAPCON), and radar control facilities (RAPCON/GCA). To provide minimum congestion, there will be a 300 statute mile separation between like assignments. A number of common frequencies will be retained, including 243.0, Emergency; 344.6, Pilot-to-Forecaster; and 372.2, Pilot-to-Base Operations/Service-Information.

Like the FAA's plan established in January for its air traffic facilities, the new USAF discrete frequency assignments are designed to reduce congestion on UHF channels and provide a clearer and safer system of radio air traffic control. Successful implementation of the plan will require thorough briefing of aircrews, including those based in Hawaii, Alaska and overseas, who are making flights to the CONUS. The changeover will delete the USAF UHF channelization plan now in the FLIP Enroute Supplement, U. S., and replace all current regional discrete frequency air traffic control plans; however, major commands have the prerogative to develop their own UHF channelization plans. ★

• *SUMMARY*

RADAR turbulence and hail avoidance tips—when you must fly through storm areas:

• Set the gain correctly, then always use this standard setting.

• If your set is iso-echo equipped (contoured) use it.

• If your set has no iso-echo feature and you are using the suggested low-gain procedure to simulate contouring, always use the same low-gain settings.

• Use ground clutter to help you adjust the tilt.

• Be sure and tilt the antenna to see the region you are about to fly through.

• Sharp rainfall gradients are indicative of sharp shear areas (turbulence).

• Watch for and avoid hail echoes:

Hooked fingers
Pointing fingers
Scalloped edges

• Avoid any Figure "6" echoes.

• Fly at least five miles from storms below the freezing level, and at least ten miles from storms above the freezing level exhibiting the characteristics discussed.

• Avoid by at least 10 miles any storm which is changing shape rapidly.

• Monitor the scope constantly, if possible, when in storm areas.

• Fly well clear of rapidly developing storm echoes.

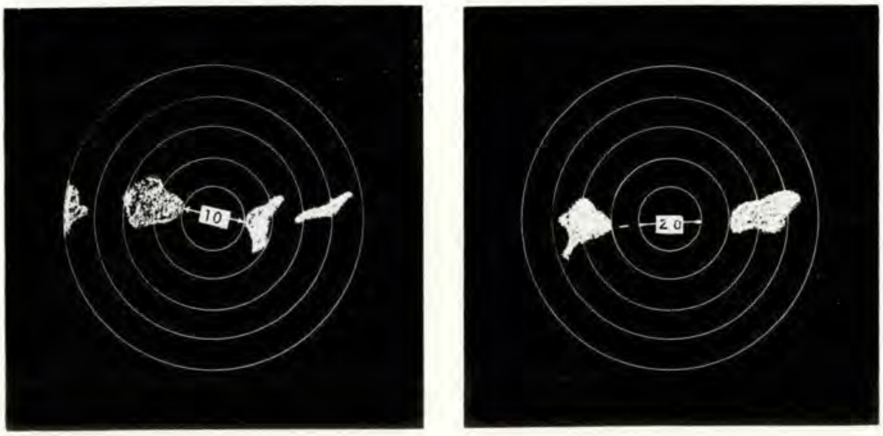
• Never fly under an overhang from a thunderstorm cloud—you are asking to be hit by hail.

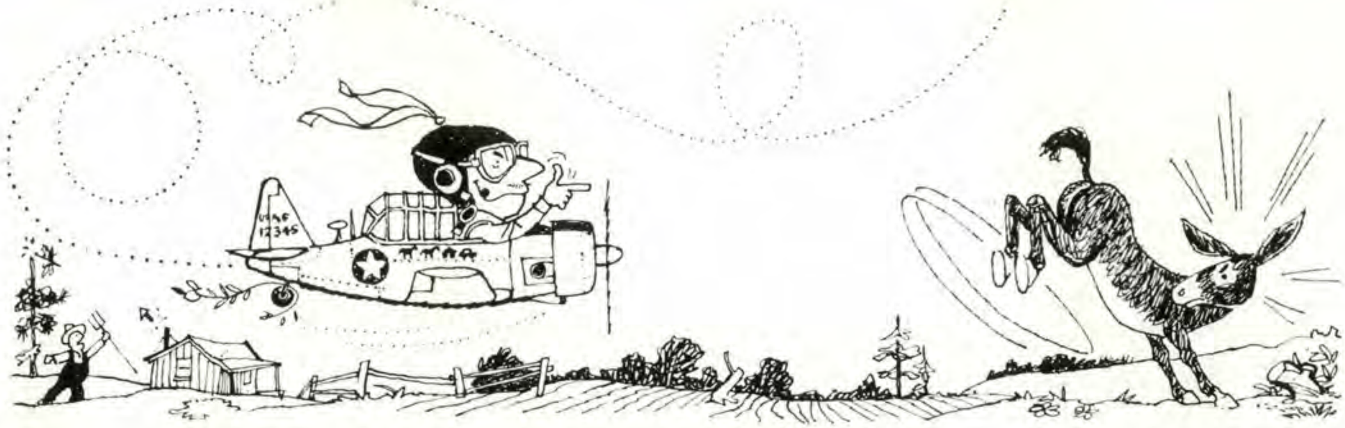
• A thirty-mile range setting is ideal for close-up detail and hail detection, but switch to the longer settings occasionally to keep from flying into a "blind alley."

• Due to power loss because of distance from target—be interested in any target which appears on the scope beyond 40 or 50 miles.

• Don't use RADAR to find out why it's rough—use it to avoid areas where it may be rough. ★

Figure 12.





OF MULES AND MEN ·

Time was, when you weren't happy with the way things were going, you could duck under a cloud, climb or descend a few thousand, alter north or south a ways, just about follow any whim you might have at the moment.

But no more; such freedom disappeared along with light-line following and railroad station buzzing. (If your command wings are quite tarnished, you may remember when you could get away with scaring hell out of Georgia mules.)

Proof? Here's a letter, typical of others, that we quote (with minor changes to protect the guilty).

> **The General Counsel**
> **Federal Aviation Agency**
> **Washington 25, D.C.**
>
> **1. Reference is made to your 30 June 1961 letter alleging that on______March, 1961, Major______ ________, USAF, ________AFB, violated Section 60.21 of the Civil Air Regulations.**
>
> **2. Your report stated that Major________ while on an IFR/VFR/OT clearance descended to flight level 310 and entered IFR conditions without amending his clearance.**
>
> **3. The Air Force investigation of this incident has been completed. The Air Force concluded the allegation was substantiated. Major __________ was given written admonition for his actions.**

Rather than pile further embarrassment on our fraternity of professionals by quoting figures, we ask that you believe that this is not an isolated instance.

In case there might be one person who doesn't know why we can't change altitudes and courses at will and buzz railroad stations and Georgia mules, it's because records in airplane morgues show that such sashaying around is extremely hazardous.

Of course, after you're dead it doesn't really matter, to you, how you got that way. But, if you survive such undisciplined maneuvering, you may almost wish you hadn't. Uncle has the whole country and its approaches pretty well blanketed with radar now and has become quite adept at knowing where you are—even when you may not be sure yourself and especially when your blip is where nobody's blip is supposed to be. Also, there are a lot of fellow fraternity members who are not the least bit understanding when they find someone else in their airspace. They're not averse to reporting this information either.

We've got to go along with these restrictions. Eyeball avoidance of tall Georgia pines may have worked in PT-17 and T-6 days, but no more, at mach speeds. How about all those traffic advisories you've received, then squinted off in the specified o'clock direction, seen nothing, then been told, "Traffic has now passed you?" Keep track some time. You will be lucky to see half the planes called, *and you're told where to look.* Sure, many are way above or below, but there are enough at your approximate altitude to make the system worth the effort. The one they call that you might not have seen could just be the one that has your number. And chances of this are enhanced considerably if either or both of you are not just where you are supposed to be.

Letters such as the one above are not rubber stamp processes. Each reported violation is investigated. Most charges involve alleged violations of Civil Air Regulations—near miss reports and deviation from flight plans or traffic control instructions.

From 1 January 1960 through 30 June 1961, 67 FAA violations were received and investigated by USAF major commands. Of the 67 alleged violations, 37 were substantiated and 30 unsubstantiated. Actions taken in the 37 substantiated cases were: Administrative (includes re-training, indoctrination, change of status from pilot to copilot, etc.) 12; reprimand (verbal or written) 22; FEB-two, Article 15-one.

Of the 32 reports of deviation from flight plan or traffic control instructions, 26 were substantiated. Of the 30 near miss reports, nine were substantiated.

That's it. There is still no evidence that mules have learned to read tail numbers, but there is evidence that violations of flying regulations are committed. Penalties can range from reprimands to sudden termination of flying careers amid battered bits of aluminum. Ignorance of the rules is no excuse. Ignorance carries no weight with the investigating board, and certainly is of no comfort to next of kin. ★

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