UNITED STATES AIR FORCE • NOVEMBER 1967

Aerospace SAFETY

THE MAGAZINE DEVOTED TO YOUR INTERESTS IN FLIGHT

Aerospace SAFETY

THE MAGAZINE DEVOTED TO YOUR INTERESTS IN FLIGHT

November 1967 AFRP 62-1 — Volume 23 — Number 11

SPECIAL FEATURES

REGULAR FEATURES

LIEUTENANT GENERAL JOSEPH H. MOORE • Inspector General, USAF
MAJOR GENERAL WILLIAM B. CAMPBELL • Deputy Inspector General for Inspection and Safety, USAF
BRIGADIER GENERAL FRANK K. EVEREST, JR. • Director of Aerospace Safety
COLONEL JAMES G. FUSSELL • Chief, Flight Safety Division
COLONEL WILLIS H. WOOD • Chief, Ground Safety Division
COLONEL CHARLES F. STRANG • Chief, Missile and Space Safety Division
MR. WILLIAM RUSSLER • Chief, Records & Statistics Group
Chief, Safety Education Group • Colonel Clyde A. Smith
Editor • Lt Col Henry W. Compton

Managing Editor • Robert W. Harrison
Feature Editor • Amelia S. Askew
Art Editor • David Baer
Staff Illustrator • SSgt Dave Rider
Staff Photographer • MSgt Bob Cooper

SUBSCRIPTION — AEROSPACE SAFETY is available on subscription for $3.25 per year domestic; $4.25 foreign; 30c per copy, through the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402. Changes in subscription mailings should be sent to the above address. No back copies of the magazine can be furnished. Use of funds for printing this publication has been approved by Headquarters, United States Air Force, Department of Defense, Washington, D.C. Facts, testimony and conclusions of aircraft accidents printed herein may not be construed as incriminating under Article 31 of the Uniform Code of Military Justice. All names used in accident stories are fictitious. No payment can be made for manuscripts submitted for publication in the Aerospace Safety Magazine. Contributions are welcome as are comments and criticism. Address all correspondence to the Editor, Aerospace Safety Magazine, Deputy Inspector General for Inspection and Safety, USAF, Norton Air Force Base, California 92409. The Editor reserves the right to make any editorial change in manuscripts which he believes will improve the material without altering the intended meaning. Air Force organizations may reprint articles from AEROSPACE SAFETY without further authorization. Prior to reprinting by non-Air Force organizations, it is requested that the Editor be queried, advising the intended use of material. Such action will insure complete accuracy of material, amended in light of most recent developments. The contents of this magazine are informative and should not be construed as regulations, technical orders or directives unless so stated.

in this issue..

Major Victor Ferrari's article, beginning on page 8, is one of the most complete roundups of information on birdstrikes that we've seen. We suggest careful reading, especially by those responsible for keeping things in order around the airpatch. While the problem is certainly biological on the one hand, involving bird control, we are inclined to believe that the ultimate solution lies in aircrew and aircraft protection. For that reason we hope the article will come to the attention of those whose knowledge and skills lie in those areas. Incidentally, since the article was prepared, there has been another fatal accident with pilot incapacitation as the result of a birdstrike indicated as the cause.

Aircrews will be glad to know that finally there is central management of the Life Support Program which should result in "More and Better Life Support Equipment for Aircrews," the title of the article beginning on page 2. The article describes the role of the System Support Manager and the Systems Program Office in the development, procurement and management of this equipment and the benefits to be expected.

Perhaps you'll recognize the characters in the item "In the Beginning," page 12. Although the story is a tongue-in-cheek fantasy, it carries a real message for all who drive our aircraft around the ramps and runways.

'Til next month — FLY SAFE! ★

AGGRESSIVENESS AND SAFETY

Lt Col Harold T. Stubbs, Directorate of Aerospace Safety

In a combat environment, air crew aggressiveness is often the key to success or failure in mission accomplishment. Aerial combat, by its very nature, is not a safe operation. It is, however, the mission — the reason for our existence in the U.S. Air Force.

Our primary mission in flight safety is accident prevention. In the interest of further protecting our combat potential, we employ every known method and device in the pursuit of the elusive zero accident rate, short of degrading mission effectiveness in combat. A happy marriage of safety and operations is an absolute necessity to guard against safety for safety's sake and to enhance our primary mission in the Air Force — operations. Safety must complement operations, not degrade or replace it.

On the other side of the coin is aggressiveness to the point that safety is degraded, or even eliminated. In this situation our accident losses can exceed those from hostile action. Aggressiveness is not enhancing the mission but is defeating it in this case, just as surely as though the enemy had planned and accomplished it. The pilot in this case may cast aside the checklist, "because this endeavor isn't safe anyway." He exhibits a lack of self-discipline in violating crew rest. He takes chances that do nothing to enhance mission effectiveness, and frequently extends himself beyond his capability and performance envelope. He is a likely candidate for membership in the infamous accident statistics club.

Following are a few true examples from an ever-increasing file:

- A flight of two aircraft departed home base for napalm delivery against a VC target of structures and sampans. The target was partially obstructed by terrain and a wooded area. During the first pass the lead aircraft struck a tree near the target causing damage to the left wing. The pilot stated that he did not see the tree until he was unable to avoid it.

- On another flight, number two aircraft on a close-support mission was positioned too close to the lead on a bombing pass. Number two aircraft sustained damage from explosion of lead's bombs.

- During takeoff roll on a combat mission, the aircraft ran off the left side of the runway. The landing gear collapsed, causing the centerline tank to rupture and burn. The pilot received second degree burns and the aircraft damage was major. Why? The rudder gust lock was not removed on preflight because a checklist was not used.

- The classic example is that of two pilots who decided that formation aerobatics were appropriate after completing an outstanding close-air-support mission. The two aircraft collided on top of a loop and both crews ejected. This unauthorized act cost two valuable aircraft.

The wise pilot, and we are thankful that he represents the vast majority, uses every asset available to accomplish the mission effectively and safely. He flies within his personal performance envelope. He exercises aggressiveness tempered with good judgment. He knows his mission and target values. He knows that the vast amount of training he has accomplished has been for one purpose — mission accomplishment. He can't hack the mission with an aircraft lost in a foolish accident. ★

MORE & BETTER LIFE SUPPORT EQUIPMENT FOR AIRCREWS

Bob Harrison

In the latter part of November several hundred people are scheduled to convene at a meeting with one objective in mind: to improve the lot of the aircrewman. The subject of the meeting will be Life Support for Aircrews, and the Chief of Staff is scheduled to be the keynote speaker. The delegates will concern themselves with many subjects, but at the root of the matter will be the men who fly and what can be done to provide them with the best in flight gear, aircraft environment and escape systems and survival equipment. Equipment for aircrews in Southeast Asia will receive major consideration.

This conference is just one indicator of a new emphasis on the life support program that runs from the top of the Air Force right down to the man in the cockpit. Two other major actions were the creation of a Life Support Systems Program Office (SPO) in AFSC and a System Support Manager (SSM) in AFLC. This means that finally the development, procurement and inventory management of this equipment has been centralized, as has long been the case with Air Force Weapons systems. The result can't help but be better equipment both to make life more tolerable for aircrews and to give them the best survival gear possible.

The SPO, unlike most others, is a permanent establishment. Recently reorganized to make it more effective, it is staffed with experienced procurement personnel, personal equipment specialists and engineers. Thus it will have the capability of determining requirements, engineering and designing new equipment, or improving existing items, and acquiring equipment more quickly and efficiently.

Significantly, one branch is assigned responsibility for future systems. This means that new aircraft designs will be a joint effort by the Aircraft and the Life Support SPOs, and that they will have to reach agreements regarding their areas of responsibility. For instance, it is generally thought that an ejection seat is a life support item. But how about oxygen systems and various connectors between the pilot and the aircraft systems? The canopy of a fighter is part of the egress system. Is it to be considered part of the life support system or a component of the aircraft?

The generally accepted definition of Life Support System is: "The total of all subsystems, equipments and individual items worn by and used by aircrew or airborne personnel of the Air Force, essential to life, health, function and safety during flight and to provide for escape, survival and recovery."

Currently both the SPO and the SSM are working at defining those items that should be considered part of the life support system. This reflects a new concept, namely that, for the first time, life support equipment will be treated as a system. There will be an integration between items that has been non-existent. We should begin to see more compatibility between components. There undoubtedly will be more logic in the contents of survival kits that will give aircrews an integrated package designed to protect them for a specific period under a wide range of circumstances.

Of course, this is looking out to the horizon, but it is in sight. Already some thinking along these lines is being converted to reality in a package that includes the new one-man life raft, an anti-exposure suit being researched and the latest in down-filled clothing.

Pilots can look forward to more comfort in flight gear. We say this because we detected a feeling—an attitude—among the life support people that signifies a change that has been taking place for some time and which will no doubt be accelerated. This idea of providing aircrews with equipment that is both functional and comfortable differs greatly from the old concept of life support, which was primary a concern based on giving the aircrew a bagful of survival gear.

It is hard to explain why this new thinking, but in talking it over with some of the people in the life support business, it became obvious that it is there. There definitely seems to be a greater concern for the individual. Perhaps this is a reflection from our society, maybe it is an inevitable result of the advances made in the equipment we fly—equipment that requires greater protection of the operator, both in normal circumstances and during emergencies. Or, perhaps, the war in Southeast Asia has speeded this development.

Undoubtedly as a result of the operating conditions there, the man is getting more attention. He must work and survive in a hostile environment. In peacetime an aircrewman may find himself in a survival situation because of an accident. In war he can be put there by enemy action and his survival and recovery become considerably more difficult.

In the April issue of *Aerospace Safety*, Col Thomas A. Collins, Chief of the Life Sciences Group, Director of Aerospace Safety, discussed the creation of the Life Sup-

Plastic shield developed by Life Support SPO for protection of crewmen using jungle penetrator. Item should appear in field soon.

New simplified survival kit container that will replace MB-1 and 2 containers for F-100 and B-52 aircraft. Container will provide stable platform during ejection and accept automatic actuator.

One model of automatic survival kit actuator developed under contract by Life Support SPO. Designed for all rigid survival kit containers except that in F-4C, item is nearing final configuration.

port SPO in his article titled, "Life Support Systems A Go-Go." Since then, as of June 1, a Life Support Systems manager has been established in AFLC. Located in SAAMA at Kelly AFB, the SSM will manage the entire gamut of life support equipment, although inventory management for specific items will continue to reside at other AMAs.

Although there are several newcomers in the SSM, many of the people assigned have been in the life support business for years as specialists in parachutes, clothing, ejection seats and other items. Their experience combined with central management should produce a much more effective program for support of the using commands. But this does not absolve the users from all responsibility. If the idea of an over-all Life Support System is going to be effective, cooperation between the SPO, the SSM and the users is mandatory.

The system should work pretty much as follows: Using commands must generate realistic requirements based on specific, documented needs. When these have been validated at Air Force headquarters the SPO will be responsible for development, first item procurement and acquiring initial training. Once the item is in the inventory the SSM will take over as manager of the system. Air Training Command and the using commands will have training responsibilities.

Of course, the above is highly simplified. The using commands will be in the act during the initial phases not only for establishing their requirements but for operational testing and evaluation of items developed and procured by the SPO. There will have to be close liaison between the SPO and the SSM for exchange of information and to prevent duplication. As items in the inventory are modified and improved the SSM and the SPO will be working together for the same purposes.

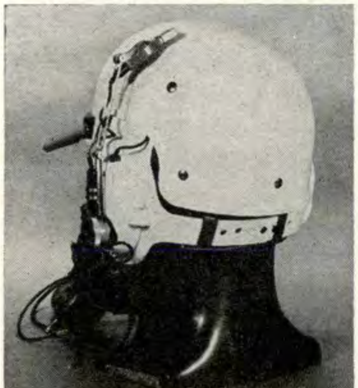
An example of the necessity for such close cooperation could be the design and development of a new life raft by the SPO coincident with the SSM procuring an additional 5000 of the old item. This could result in a vast waste.

Both the SPO and SSM are still getting manned and have been using most of their assets in support of Southeast Asia. However, the SPO is now negotiating memorandums of agreement with the aircraft SPOs for participation in all life support requirements.

There are, of course, some problems. Some of these are peculiar to the equipment. For example, manufacturers may be reluctant to expedite production of an item under a $12,000 contract while busy with a

New insulated life raft described in story. Main features are easier access, greater protection. Raft increases survival time in cold water by factor of three.

Prototype MBU-7/P oxygen mask. Improvements over MB-5/P include better retention under high G forces, reduced restriction to breathing. Mask is now in Operational Testing and Evaluation.



Proposed improvement to HGU-7/P helmet for non-ejection seat equipped aircraft. Helmet will improve headset suspension to provide more comfort. It has better visor and should fit better.

Prototype of two-piece flying suit designed to meet users' desires. Proposed material for suit which is now under development will be fire resistant.

Walk-around sleeping bag, an integral part of three-part environmental survival system. It will be packed with new insulated raft. Down-filled garment will be worn on outside with proposed new anti-exposure suit underneath.

Life Support System: The total of all subsystems, equipments and individual items worn by aircrew or airborne personnel of the Air Force, essential to life, health, function and safety during flight and to provide for escape survival and recovery.

several million dollar job for someone else. And many life support item contracts are small dollarwise.

Some of the requirements submitted by users have been less than realistic. Undoubtedly, there are many, many items we would like to have. But are they all really necessary? Perhaps this depends on where you are, but the fact remains that funds are not easy to come by, which means that an item had better be well documented as to need.

Commands have requested new equipment when already existing items might have done the job. This doesn't mean that the users are the bad guys. They are the ones who have to depend upon the stuff they have to work with. They want what they think they need and they want the best.

Southeast Asia Operational Requirements (SEAORS) have been receiving priority treatment. Normally, once an item has been designed, a limited number has been procured and sent to several commands for Operational Testing and Evaluation (OTE). Items resulting from SEAORs, however, are frequently procured and sent to the theater concurrently with OTE because urgent need may dictate such action.

One thing that could be improved is the reporting on equipment tested in the field. Some of the reports have been pretty sketchy, along the order of "it works fine," or "it doesn't do the job." This doesn't tell the engineers at the SPO very much. They need to know WHY, with specific data to support the assertion. The only winner will be the people who have to use the equipment.

There is a move in the commands toward establishing life support offices in the DO at several levels. Presumably these would be the focal point for life support supply, maintenance, training and OTE as well as liaison with the SPO and SSM.

Earlier we talked about life support as a system and briefly mentioned some specific items. To elaborate a bit, there is the concept of an anti-exposure or survival system. To quote SMSgt John R. Schumann, a man with long experience in survival equipment testing and training, and now assigned to the Life Support SPO, "This would be a complete system that would serve as a means of flotation as well as provide protection from cold water and cold land environments. Such a system is being developed and an early interim system should soon make its appearance on the Air Force scene. The system is composed of a new concept in anti-exposure suit plus an insulated life raft and down-filled clothing. The one-man insulated life raft is about ready to make its debut.

"This raft has been tested in the Arctic Aeromedical Laboratory and would extend present survival time of six to 10 hours in 32°F water and 18°F air to better than 36 hours. It is also easier to get into; in fact, a poor swimmer can get into it over the large end. It is roomier, more stable, and packs in less volume than the present MB-4. Of greatest importance is the fact that it will, with the survival suit, allow a downed airman to survive in cold Arctic seas until rescue can be achieved."

The raft and the down-filled clothing are already a fact. The anti-exposure suit is another thing. Aircrews have tended to avoid these suits like the plague. They are uncomfortable and not as efficient as they might be with the result that many a pilot has taken the gamble that he won't need it.

Now something new has appeared. This is a material that is fabricated in such a way that while dry, its pores allow a garment made from it to "breathe," but which upon contact with water close tightly. An anti-exposure suit made from the material would be lighter, cooler and consequently more comfortable. And it would protect the survivor both in a dry or wet Arctic situation.

The problem has been that the material is hard to come by. The manufacturer apparently is reluctant to produce it in small quantities because of the cost of production. However, the SPO has a commitment for several hundred yards of the material with which some experimental suits will be made for OTE.

This is just one application of the systems approach to life support equipment. We can look forward to further development of this concept. It has high level support and, finally, central management that will provide the direction, coordination and control that have been lacking. Most important, there is enthusiasm among the people in the SPO and the SSM.

The policy at the SSM is "if you need help, let us know." They encourage users to come to them with their problems or for information. There are several routes. One is by deficiency reporting. There are incident reports, OHRs, URs, letters, or even the telephone.

SAAMA, in addition to being SSM for life support equipment, is inventory manager for many items. So if you call you can talk to someone who either knows the answers or can direct you to the individual who does.

This kind of support is directed toward one goal: to give the man in the cockpit what he deserves. The best. ★

the I.P.I.S. approach

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

PROCEDURE TURN

Low altitude terminal charts revised in accordance with TERPs (U.S. standard for Terminal Instrument Procedures) have two headings depicted on either side of the procedure turn symbol in the plan view. These headings on the barb symbol are provided for the convenience of the U.S. Army. USAF pilots shall disregard these headings and fly procedure turns according to procedures outlined in AFM 51-37. See Special Notice in the low altitude terminal charts (AL).

ETE TO ALTERNATE

The "ETE to alternate" block of the DD Form 175 should contain the time required to fly from the original destination IAF to alternate IAF at the last planned en route cruising altitude. See Preflight Procedures, FLIP Planning, Section II.

INITIAL APPROACH AIRSPEED

The maximum airspeed allowed when crossing an initial approach fix will be changed in the next change to AFM 51-37, INSTRUMENT FLYING. Previously, the maximum crossing airspeed was the same as maximum holding airspeed. The revised maximum allowable airspeed for crossing the initial approach fix, when holding pattern entry is not required, is the same as penetration airspeed. Authority to implement this procedure has been coordinated with USAF and all MAJCOMs have been notified.

SLIDING SCALE WEATHER MINIMUMS

The significance of the S/S symbol found in the landing minima block of the terminal approach charts has been questioned by several pilots. This symbol is for use by U.S. Army pilots, who are authorized a sliding scale for weather minimums. With every 100-foot increase in the ceiling above published minimum, the visibility may be decreased by $\frac{1}{4}$ mile to a minimum of $\frac{1}{2}$ mile. This procedure is not applicable to USAF pilots.

APPROACH/RUNWAY LIGHTING FAILURE

Since the implementation of TERPs, the IPIS has received numerous queries concerning the effects of lighting failure on landing weather minima. Hq USAF has recently provided policy guidance to the field on this subject. Following is an extract from this policy guidance:

> "In view of recent analysis of airfield lighting failure, and methods for treatment of equipment outages, it is our opinion that application of an inoperative components table would result in unnecessary pilot/controller confusion. Until the many problems associated with airfield lighting requirements and visibility credit are resolved, we do not intend to require use of an inoperative components table. However, where airfield lights or other component failure requires issuance of a Notice to Airmen (NOTAM), landing minima should be computed on the basis that the applicable component is not available, and appropriate landing minima should be included in the NOTAM."

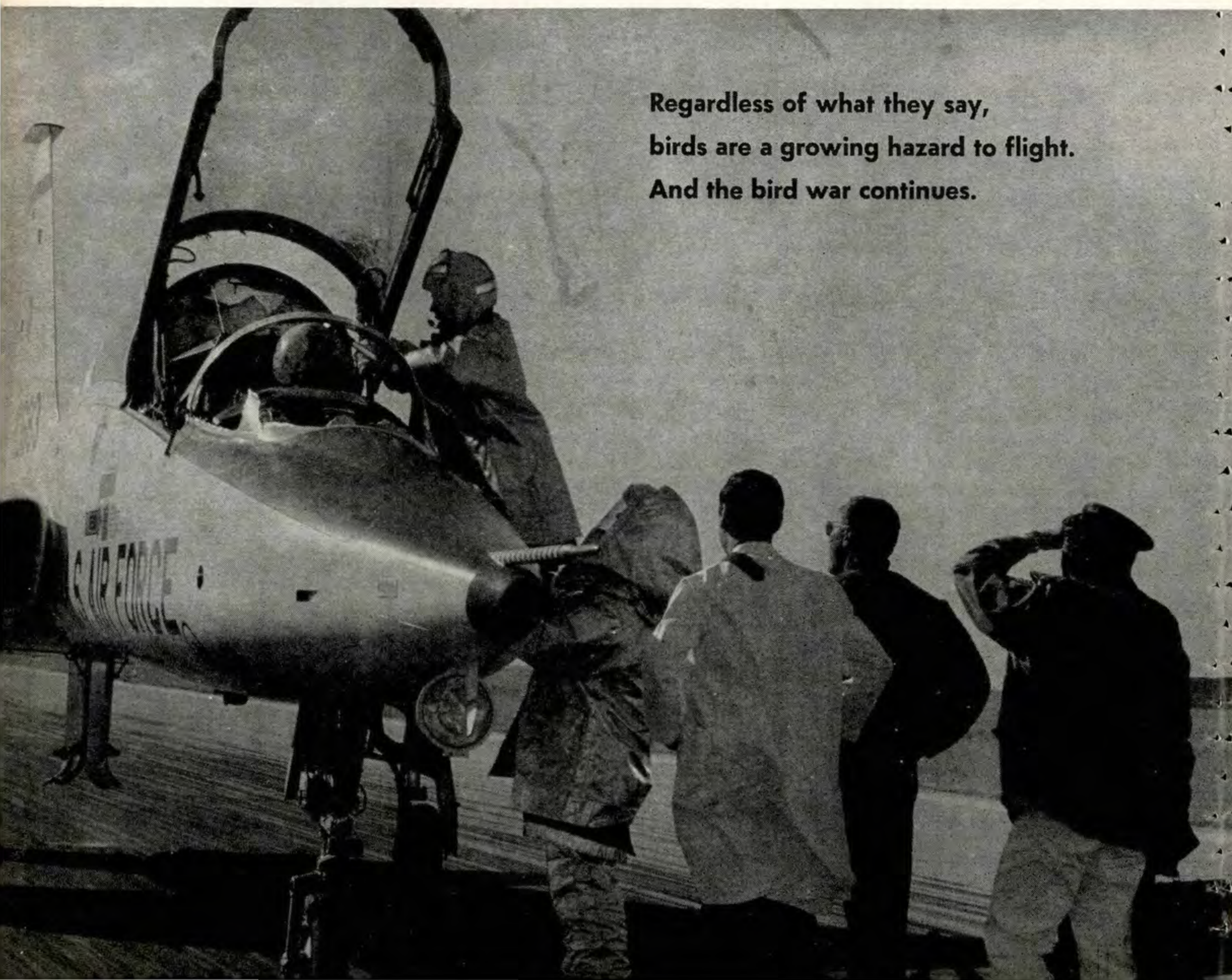
In summary, *no requirement presently exists* for Air Force pilots or air traffic controllers to *compute weather minima* due to light failure. If a runway or approach lighting system is unserviceable for sufficient time to require issuance of a NOTAM, and visibility reduction credits have been allowed in the minima for approach(es) to that runway, then new minima should be computed by base operations and published in the NOTAM.

HONK WARBLE TWEET

Maj Victor J. Ferrari, Jr., USAF, MC, Life Sciences Group

EARLY aircraft with their reciprocating engines and large propellers were relatively unaffected by birdstrikes. Their speeds were too slow to produce major structural damage to the aircraft and so man tended to ignore the birds.

With the advent of the jet engine, immunity to birdstrike damage was lost. Major structural and windscreen penetrations became common as airspeed increased. The jet engine is prone to ingest anything movable because of its powerful suction. In fact, several humans have been sucked into these engines during ground operations. The compressor blades are, however, very fragile. When one is broken off it produces a chain reaction of foreign object damage. Thus, the ingestion of even



Regardless of what they say, birds are a growing hazard to flight. And the bird war continues.

one bird causing the failure of just one blade can produce total engine failure.

The birdstrike problem is international in scope and recognized as such. In addition to efforts by individual nations, there is within NATO a birdstrike committee working to solve the problem. In the U.S. an interagency council has been formed which includes the FAA, Bureau of Sport Fisheries and Wild Life, Department of Agriculture, the Armed Services, the Audubon Society and many others. The special assistant for Natural Resources Conservation to the USAF Inspector General coordinates the Air Force activity in this project.

This article is based on a study by the author of the problem of birdstrikes which were reported in the USAF from January 1956 to December 1966. The purpose of the study was to obtain statistical information of value to the national and international agencies that are investigating this problem, to define those problems that are unique to the Air Force mission, and to bring these factors into proper perspective so that research can be directed toward the most serious hazards.

The first factor examined was time, both the seasonal and the daily distribution of birdstrikes. In the fall, fast moving polar fronts move large concentrations of birds rapidly southward. There is very little activity in December and January. In the spring the weather changes are more gradual, resulting in a leisurely northward migration, beginning in late February, peaking in April and ending in May.

Figure 1 shows the time distribution of USAF birdstrikes during a 24-hour period. The majority of birdstrikes occurs during daylight hours when human visibility is best. Visibility is not a factor in birdstrikes, since in few cases was the bird seen before the collision and never in time to avoid the strike.

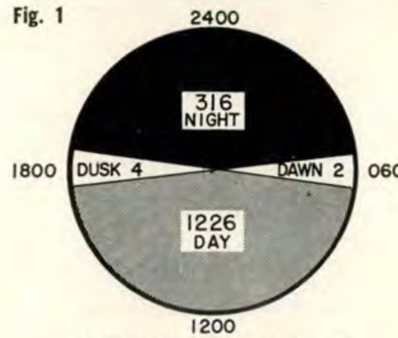
Evaluation of the geographic distribution of birdstrikes was a problem as the reporting and coding did not provide accurate geographic location. It was possible, however, to sort them into the six major areas of the CONUS. The distribution was fairly even throughout the central U.S., the northeast and northwest. The southeast and southwest, however, showed significantly more than the rest of the country. Three factors would help to explain this: first, these areas are favorite wintering grounds for migratory birds; second, being coastal areas, they have large native populations of sea birds (of the gull family); and third, flying activity is greater in the south because of better weather.

Figure 2 depicts the distribution of birdstrikes according to the phase of flight in which they occurred. Sixty-one per cent occurred on or within one mile of the airfield. Thirty-nine per cent occurred enroute, of which 14 per cent were low level missions and 25 per cent normal cross country flights. This is in contrast to present civil experience where almost all of the strikes occur within one mile of the airport. This difference is based on the extensive low level training mission of the USAF.

The risk of a birdstrike increases closer to the earth: 27 per cent within 100 feet of the ground, 25 per cent between 100 feet and 2000 feet; and 21 per cent from 2000 to 3000 feet. On the other hand, the rare high altitude strikes cannot be ignored as they tend to involve larger birds with increased threat of injury to aircrews.

NR. BIRD STRIKES/TIME OF DAY

Fig. 1



TIME NOT REPORTED	18
TIME REPORTED	1548
TOTAL	1566

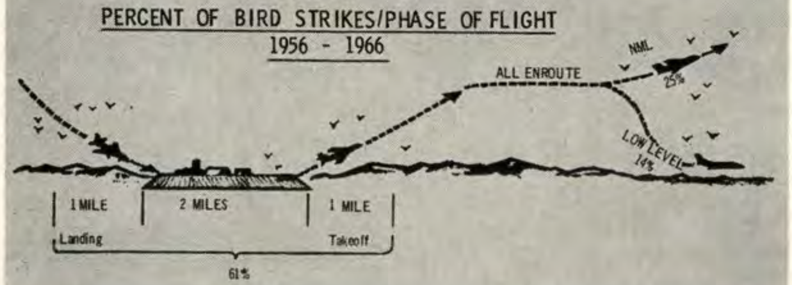
How high can birds fly? Aerodynamically this is uncertain. However, geese have been reported at 20,000 feet. Physiologically, birds can function much higher than man. Mr W. H. Bird of Engineering Research and Development Department, Air Canada, Montreal, reported that a mallard duck performed well on a treadmill in a hypobaric chamber at 30,000 feet.

The risk of low altitude flying is also demonstrated by comparing birdstrikes (1956-66) with five types of bombers. Two types have almost twice the rate of the others; they also have more frequent low level missions.

SPEED AND ACCELERATION

The speed at which birdstrikes occurred was not routinely reported so a different approach was used: com-

FIG. 2
PERCENT OF BIRD STRIKES/PHASE OF FLIGHT
1956 - 1966



parison of the birdstrike rate for reciprocal engine vs jet powered aircraft, by type of aircraft. The jet aircraft have a significantly greater rate of birdstrikes. This is logically a function of greater speed.

A closer look at the birdstrike rate of different jets points up another important factor (Figure 3). Of the jet trainers, the T-38 has a significantly higher rate. The supersonic century series aircraft with afterburner also show this increased rate compared to subsonic aircraft. Since the majority of supersonic flights are conducted at altitudes above the bird flight zone, the difference here must be related to the *rate of acceleration.*

Positive identification of the birds was not made in most of the birdstrikes reported. However, of those identified, gulls, starlings and blackbirds were most frequently involved. Looking at the birdstrikes occurring on or near airports, it becomes apparent that each airport has its own unique problem depending on the local ecologic pattern. The native resident bird population determines the major birdstrike hazard associated with airports.

The hazard from migratory birds, unless roosting or feeding on airports, is predominantly to the enroute phase of flight.

Figure 4 shows the number of birdstrikes reported in the USAF for an eleven-year period. There are two important aspects to this curve. First, prior to 1965 only birdstrikes producing aircraft damage were reported. In 1965 all birdstrikes were reported. This graph demonstrates that the RISK of birdstrikes is greater by a factor of six than that predicted by normal trend analysis using only strikes resulting in damage. The second point of interest is the upswing in 1966. This probably indicates a greater awareness of birdstrikes with increased reporting, but may also reflect the increase of birdstrike potential as our flights become shorter and faster, with a relative increase of exposure to the low altitude and traffic pattern hazard.

ACCIDENT BRIEFS

Of the 839 birdstrikes reported in 1965, none resulted in accidents. Only 294 produced any aircraft damage; 545 produced no damage at all. With the great majority of birdstrikes causing little or no damage, is the present concern justified? The answer to this question lies in the catastrophic potential of each and every birdstrike. An example often used was the crash of a Viscount airliner in Maryland in 1962 after a Whistling swan struck the horizontal stabilizer, producing a major structural failure and loss of control.

Although there were no accidents in 1965, in 1966 a series of disastrous birdstrikes occurred in the USAF.

- A T-38 jet trainer struck a sea gull just after takeoff. The bird penetrated the windscreen and struck the pilot. His helmet and visor prevented serious injury but foreign object damage to both engines forced the pilots to eject.
- A T-37 jet trainer on a pre-dawn training mission struck a large Sand Hill crane which penetrated the windscreen and killed the pilot in the right seat instantly. The other pilot recovered the aircraft.
- An F-100 on takeoff struck a large flock of gulls just before gear retraction. On landing, the gear collapsed due to a damaged gear-down lock.
- An F-104 encountered a flock of gulls just at rotation speed. Engine ingestion occurred followed by total engine failure. The airplane was destroyed on barrier engagement but the crew escaped.

These briefs demonstrate the three major damage potentials of birdstrikes: failure of a major component of the airframe, engine ingestion and

FIG. 3

BIRD STRIKE RATE/SPEED VS AIRCRAFT

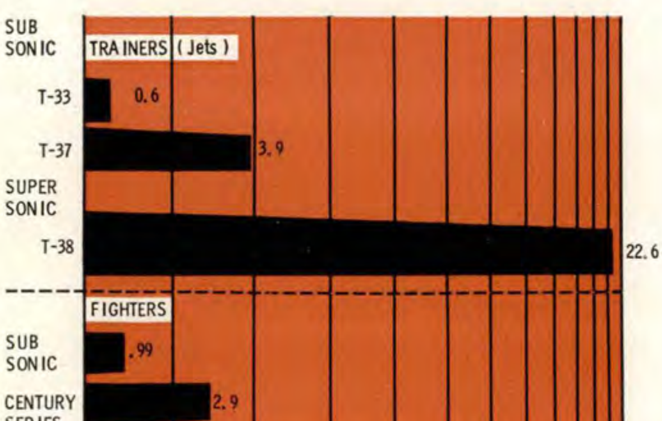
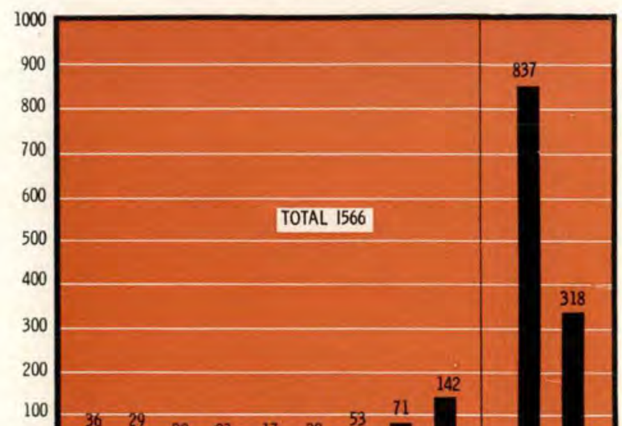


FIG. 4

NUMBER OF BIRD STRIKES REPORTED IN USAF

1956 through 1966



failure, windscreen penetration with crew injury or incapacitation. They also clearly demonstrate the critical hazard which birdstrikes present to the aviation industry. The annual cost to the USAF resulting from birdstrikes is estimated to be as high as 10 million dollars! In 1965 alone birdstrikes resulted in the replacement of 75 jet engines costing up to $130,000 each.

The picture of a T-37 canopy penetration (Photo Nr. 1) vividly demonstrates the damage potential of birdstrikes. Notice the explosive force of this windscreen penetration which sprayed glass and gore over the entire cockpit. Photo Nr. 2 indicates the potential hazard and clearly demonstrates the value of personal protection. Although badly damaged, this visor prevented serious injury and the pilot landed the aircraft. Visors prevented serious injury whenever they were used. Further research and development should result in improvements in both windscreens and visors. A double visored helmet having a clear visor for night use is in the procurement phase now and after test completion should be available for field use in the near future. It will be necessary to develop operational procedures as to visor use, considering the known hazard potential in the various areas, seasons and flight envelopes.

Some ecologic factors are basic to birdstrike control problems.

Every airport has a unique problem based on its native fauna and flora. For example, many western airports have a high population of rodents. The underbrush control practiced on these airports makes easy hunting for the short horned owls which congregate on airfields. In other areas adjacent to the sea coast gulls rest on the runways after feeding. Control measures must be based on accurate ecologic surveys of each airfield.

Birds are attracted to airports, which routinely have high numbers of birds. Some reasons for this are:

Food supply is abundant. Seeds and berries abound. The lack of cultivation attracts rodents. Mowing makes them easy prey for predator birds. After a rain runways are covered with earthworms driven to the highest point of land. Dumps are traditionally associated with airfields, attracting many scavenger birds.

Water is often present in the bar ditches left from runway constructions. This attracts water fowl and gulls.

Resting areas. Gulls and many shore birds rest in large flocks on the warm runways after feeding. Blackbirds and game birds abound in the grass and brush along the runways, where they rest and/or nest.

Flyways from roost to feeding are frequently cross the airfield. At Moody Air Force Base, for example, tens of thousands of red wing blackbirds cross the airfield twice a day. Air operations virtually stop during these periods.

There is a marked species specificity noted in the reaction of birds to deterrent, scare or warning devices. For example, at Moody Air Force Base a tape of the T-37 engine noise was made and played. This proved very effective in changing the blackbird flyway. However, other species paid no attention to it. This species specificity complicates the control problem tremendously.

Although the problem of birdstrikes is basically a biological one, the ultimate solution will best be achieved through an approach utilizing biological factors and engineering that will provide airframe, windscreen and engine protection. Here are some suggestions:

Continued surveys of airfields and analyses of birdstrikes are necessary to define specific problems and devise specific solutions.

Biologic studies are necessary to provide deterrent or warning devices. One example of such research is the effect of pulsed microwaves on young chickens. A 23 cm microwave pulsed at 84 CPS causes severe disorientation in young chickens. Additional studies of this nature may develop practical methods of reducing enroute birdstrikes.

Biologic research in migratory and instinct patterns may provide a method of controlling or changing migratory flyways.

Botanical research can assist by providing a ground cover for airports that is repellent to birds.

Pending ultimate solutions, engineering research is necessary to provide radar detection and warning, bird-proof engine design, windscreen strengthening, and additional personal protective devices. ★

Damage to T-37 in which one pilot was killed. Sand crane struck nose of aircraft, traveled up cowl through windscreen. Cockpit was a mess.

Left seat pilot in aircraft shown above holds helmet and mask he was wearing at time of birdstrike. Note feathers and gore on flying suit, helmet and mask.

There were 366 taxi accidents and incidents in 1965-66, or one every other day. Here's how it all started, along with that first set of rules to prevent such mishaps. Perhaps now is the time for all aircraft operators to review today's rules.

in the beginning....

SMSgt W. C. Brenton, Directorate of Aerospace Safety

"YOU know, Orville," said Wilbur, "ever since we took off the skids and put on wheels we have been having lots of troubles. I think we ought to go back to skids."

"I don't know why you'd say a thing like that," Orville replied. "It lands and takes off a lot better with wheels."

Wilbur felt a little uneasy, criticizing his brother, but he felt compelled to say his piece. "Well, you have to admit they don't help once you're in the air; and on the ground they are just a headache. This is the third time this month that you have run into the barn."

"That may be so," replied Orville huffily, "but you hadn't ought to get so close. After all, I get tired of working all night on this thing. Besides that—how about the fence you hit last week?"

Orville felt like he should defend himself. As long as he was flying the machine, he was in charge and he could use his own common sense. "I was just trying to get up close to the barn where you wouldn't have so far to pull it, and this is the thanks I get!"

"It wouldn't make any difference how far I had to pull it, if you would let me get that horse the way I wanted to," said Wilbur. "That way you could stop where it's nice and clear and the horse could pull it in the barn."

"We tried that horse idea once before, and you remember what happened."

"That was because that farmer wanted to lead the horse and he forgot about how far out the wings went. If I had been leading the horse it wouldn't have happened." Wilbur defended himself, "After all I've had a little training."

"Well, it sure didn't look like you had any training the other day when you let me run into that cow!"

"I explained to you a million times that I waved my arms at you and tried to get you to stop."

"How did I know what you meant with all that arm waving. I thought you were being stung by a hornet and were trying to kill him!"

"Sure you did!" Wilbur was getting riled, "And I guess you didn't hear me ringing my cow bell either to warn you to stop?"

"Look," Orville explained slowly, "the whole purpose of the cow bell and arm waving is so we can communicate back and forth—right? Let's make up some rules and signals that we can both understand. That will solve the whole problem.

"I still think it's a better idea to take the wheels off and avoid this wandering around all over the pasture and running into things," Wilbur said. "We could still use a horse too."

"No, we ain't going to take the wheels off and go back to skids. So you might as well make up your mind to that! Now let's talk about some hard and fast rules that will stop this business of running into things. First of all—how about distance? How close do you think it would be safe for me to get to the barn while the engine is running?"

"Not less than a mile."

"Come on, Wilbur, be serious."

"I am serious—if you run that thing closer than a mile to the barn, you'll hit it sure as shooting!"

"You got no faith, Wilbur."

"I got more faith than time to fix them wings."

This didn't make sense to Orville, but he decided not to press the matter.

"Well, how about this? Suppose we make a hard and fast rule that you can't run the machine around without someone on each wing tip watching for fences and things?" he asked.

"That might work out ok," Wilbur said, "but are you going to be willing to wait until the men get on the wing tips before you go running around the barn?"

"Sure I'd be willing to wait," snorted Orville, "as a matter of fact, I'd even stop if I got within 25 feet of a barn or fence or anything else."

"25 feet!!" Wilbur wailed, "Where did you get that 25-foot business?"

"I made it up. That sounds like a good close figure to me. If the people on the ground are on the job, we won't have any problems at all."

"I'll have to admit one thing, Orville," Wilbur said, "if that rule about running the machine no closer than 25 feet to the barn is enforced, there is no way under the sun that it could hit anything."

"Yes, that is a very good rule," Orville added, "and I'm sure that we won't have any more damaged wings on our machine."

"I don't suppose you would care to wager a little something on that, would you, Orville?"

"Wilbur, you are a very pessimistic man," said Orville. "And to make sure we don't have any more accidents I'm going to make up some rules for us to follow."

GROUND RULES
FOR FLYING MACHINE

The following rules are established for the handling of our flying machine while it is moving on the ground. A copy of these rules will be posted on the barn door and another copy will be posted in the office next to the picture of Harry's prize bull.

1. The man flying the machine is responsible that nothing happens to his machine.

2. When the machine lands a man will take a grip on each wing and make sure his wing does not hit a fence, the barn, or a cow.

3. Each man holding the wing will have a cow bell for signaling.

4. Each man will wave his hands back and forth across his face if he wants the machine operator to stop.

5. One man will be in front of the machine and all other wing holders will signal him on what they want to do.

6. If the machine comes within 25 feet of the barn or fence it will be stopped and not go any further. ★

Orville
Wanna bet on this? W.W.

THE HUNTING SEASON IS UPON US with its own peculiar brand of mayhem. But appropriate caution can bring you and your companions back from the field alive and uninjured. LIKE ;

Never lean a loaded gun against anything.. a tailgate, a tree, a bush or a stump. It can fall over or be kicked or a dog can knock it down. Keep your gun carefully placed until all hunters in your party are ready for the field.

When walking abreast , point your gun in a safe direction... usually up.

Keep the Safety on and never put your finger inside the trigger guard except when ready to fire.

Never shoot over another person's head. Stay abreast of each other at all times. Those in the center should fire only at game that is straight ahead. Game to the side should be taken by the hunter on that flank.

Don't prop guns on fences where they can fall in dirt or snow or accidentally discharge. Unload the gun or open the action. Hold the gun firmly in one hand as you swing across the fence. With a companion, unloading is not necessary but actions should be open. Hunters then hold guns for each other.

Wear bright clothing. Blaze orange or yellow is best. A handkerchief hanging from the pocket could be mistaken for a deer tail.

Know and obey local hunting laws.

Make sure the shell fits your weapon. The wrong size can blow up a gun in your face.

Never fire at a flat hard surface or the surface of water. The shot may richochet.

Guns are for shooting. They're not sticks, canes , probes, etc.

While holding a gun, never run or jump a ditch or climb a tree.

Unload your gun before entering camp, cabin or house. If you are approached by a game warden or a private property owner, unload your gun.

Do not shoot over a rise of a hill or bank. Be sure you can see behind your target , too.

Learn self control. Don't let excitement pull the trigger.

Unload any gun you carry in a car or boat. Check your state law on carrying a gun in an automobile.

Carry your weapon so that you control the aim of the muzzle if you should stumble.

Do not hunt alone. Use the "BUDDY SYSTEM ", and carry a compass.

Never leave a weapon or ammunition within reach of children.

Never point a weapon at anything you do not intend to kill.

Never shoot in the direction of a dwelling.

Open the breach before inspecting the barrel.

Forget alcohol before and during a hunt. Save the refreshments until afterwards.

Destination:

This story is true. We merely eliminated names and places for the usual (and in this case, obvious) reasons.

davey jones

Lt Col Wallace H. Carter, Directorate of Aerospace Safety

The mission was a pararescue team drop to administer a blood transfusion to a critically ill, bleeding ulcer patient aboard a freighter 600 miles at sea. The request was received from the Coast Guard at about 1400 hours and hurried preparations were made in order for an HU-16 to arrive at the freighter prior to darkness. Takeoff was delayed while attempts were made to locate a pararescue team. Finally the aircraft took off with only one qualified parachutist aboard, so the plan to deploy the team was doubtful. Decision was made to continue to the freighter and evaluate sea conditions before making a final decision on whether to jump.

When the aircraft arrived in the area, sea conditions were three to five feet primary swells at 210 degrees, winds five to eight knots from 130 degrees, with showers and squalls in the area. Secondary swells were noted to be approximately one to three feet in height. It was considered a calculated risk, but the decision was made to land. The ship was notified to have a life boat in the water, then drop tanks were jettisoned to bring the aircraft weight within limits and a normal landing was made near the freighter. Because of the sea conditions, the medical team was split into two parties. The first party of two, with blood and gear, were let out on 210 feet of rope. They were picked up by the life boat and transported to the freighter. The other party of two was placed aboard a life raft and also let out on a 210-foot rope. The freighter's life boat, however, did not return for these two men. Radio contact had been lost. The life raft was maneuvered to within 20 feet of the life boat and cut loose because of approaching darkness.

The HU-16 was buttoned up and an immediate takeoff was attempted on the landing heading of 210 degrees, but the winds had increased and aircraft directional control could not be maintained. Aircraft course was reversed and takeoff was attempted on a 030-degree heading. Just as the aircraft was coming up on the step and approaching the stern of the freighter, the second raft was spotted directly ahead with the freighter's life boat in pursuit. The pilot attempted to turn the aircraft to the right by differential power and reversing the right prop. One medical team member dived overboard, one of the floats hit the end of the raft and the other member was dumped in the water. The aircraft came about in the water and the crew observed the life boat retrieve the team.

One other takeoff attempt was made, but was aborted due to darkness. The freighter was called and assurance was received that the medical team members were all on board and O.K. The aircraft was then secured to the stern of the freighter with a 1000-foot rope attached to the aircraft's pendant cable. Extra crewmembers were transferred from the aircraft to the freighter, Aldis lamp signals were arranged for every half-hour and radios and APU were shut down.

Rough seas continued, with showers. During the night the flight mechanic and radio operator were seasick. A bilge check was performed every hour, with Nr. 5 noted taking on water. At 0430 the aircraft radio operator attempted, unsuccessfully, to raise the freighter on radio. Aldis lamp signals were not answered. The crew began to pump Nr. 5 bilge at 0500, with the pump working only on single action. The crew was exhausted by 0700 with about half the water out so the pumping operation was discontinued. Inspection of the aircraft at first light revealed that the fixed trim on the left aileron was bent up and ripped loose, the right elevator had a hole near the trailing edge, the fuselage skin at the rear of the left wheel well was turned back and the gear appeared to be slightly out. All excess equipment was jettisoned.

The radio operator still could not raise the freighter. JATO installation was begun with numerous delays due to the flight mechanic's seasickness. Two JATO's were mounted on the right side, but there was considerable trouble getting the top one to check out. The freighter was finally raised on radio, advised of intentions to cut the aircraft loose, and requested to retrieve the tow line and proceed full speed ahead on a 210 degree heading so that a takeoff could be attempted in the ship's wake. The freighter advised it would take 30 minutes to get under way. Meantime, the waves were building.

The first takeoff was started at approximately 0830 with 10-15 knot winds from 120 degrees and 7-10-foot swells on the surface. JATO was fired but not felt. Takeoff was aborted. Inspection revealed the lower JATO was missing and the upper had failed to fire. It was jettisoned. The freighter was requested to do a 180-degree turn and another takeoff was attempted but aborted on a heading of 220 degrees. The aircraft was then turned behind the freighter on an approximate heading of 040 degrees and still another takeoff was attempted but aborted due to rough seas. The pilot then tried to taxi behind the freighter as it proceeded toward land, but he was unable to turn the aircraft due to squalls with 25-30-knot crosswinds. After finally conquering this situation, the aircraft proceeded behind the freighter at 3-5 knots.

Thirty minutes later the doctor who had been put aboard advised that the patient's condition was such that the freighter should be allowed to proceed full speed ahead for land and medical assistance. After considerable deliberation by the pilot and the doctor, and after studying weather conditions, the pilot asked the freighter to come about so the crew could evacuate the aircraft.

By 1030 the freighter's life boat was in position, 50 yards from the aircraft. The overhead life raft was jettisoned from the aircraft, but the crew was unable to get aboard because a squall was upon them. The life boat was then waved to the aircraft entrance door and the remaining five crew members got aboard. The left rear windows of the HU-16 were broken by the life boat. Finally, after being temporarily lost in the squall, the men in the lifeboat located and boarded the freighter.

As the ship proceeded for land, the HU-16 was last seen floating gracefully in 10-12-foot seas. It has not yet been found and is presumed to be resting peacefully in Davey Jones' Locker.

Now let's take a look at some of the weak areas identified by the accident investigation board. Primary cause was attributed to sea conditions. Among the contributing causes were:

• Failure of the JATO bottles to fire. The investigation revealed that the crew failed to follow checklist procedures when installing and arming the JATOs.

• Inadequate mission support as follows:

1. Lack of a definitive agreement between the Coast Guard and responsible USAF agencies for employment of Rescue Reserve forces in support of SAR missions.

2. Limited communications equipment installed in Rescue Reserve HU-16 aircraft.

3. Failure of the ARRSQ (Res) unit to continually man their Rescue Coordination Center during the course of the mission.

4. Inadequacy of the hand-operated bilge pump.

• Collision with the life raft previously launched from the aircraft. The pilot failed to assure that the transfer of personnel from the aircraft to the freighter was completed and the surrounding area clear prior to the attempted takeoff.

Additional findings identified by the board included:

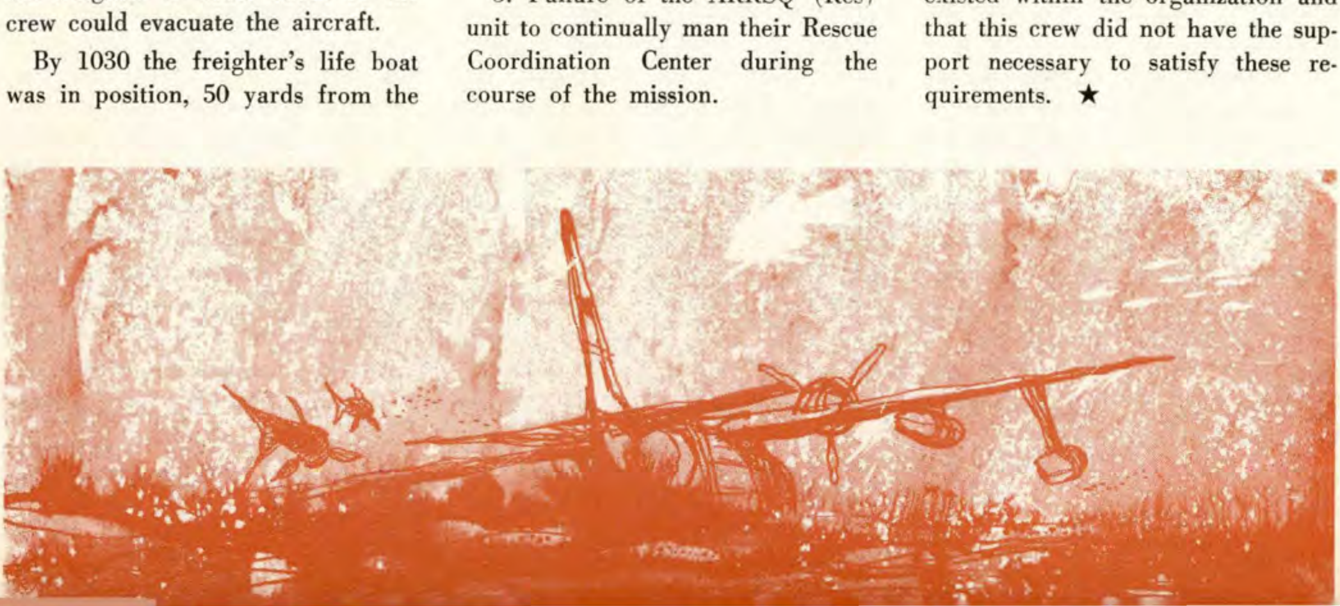
• Takeoff gross weight on departure from home station exceeded the maximum allowable waiver limit of 37,500 pounds.

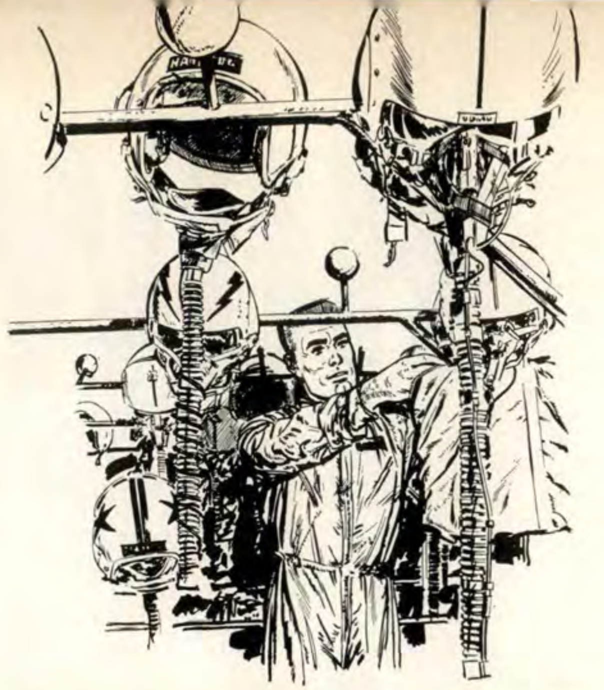
• Members of the unit's Pararescue Section were not fully qualified (specifically, scuba) and were not medically equipped as prescribed in pertinent directives.

• Host base medical personnel were not thoroughly familiar with the rescue procedures, techniques and capabilities of the Rescue unit.

• Rescue Reserve HU-16 squadrons were not required to maintain currency in open sea operation IAW Attachment 39, ARRSM 55-1.

In summary, we must commend the crew for delivering the goods. But the price was pretty high. These men frequently risk their lives in the service of others. They deserve the best in equipment, training and supervision, both for mission accomplishment and for their own protection. The findings in this accident indicate that serious deficiencies existed within the organization and that this crew did not have the support necessary to satisfy these requirements. ★





REX RILEY'S
CROSS COUNTRY NOTES

SPEED LIMIT. A recent FAA Information Bulletin (Nr 67-66) tells of a proposal to enforce a maximum speed limit of 250 knots (288 miles per hour) below 10,000 feet mean sea level. The purpose is to give pilots more time to "see and avoid" other air traffic in the nation's most heavily traveled airspace.

"At the present time, there are no speed limitations imposed on en route air traffic. The only speed restrictions are those prescribed for aircraft arriving at an airport. They are limited to an indicated airspeed of 250 knots when below 10,000 feet MSL and within 30 miles of their destination. Within the immediate terminal area, the permissible speed drops to 200 knots for turbine-powered aircraft and 156 knots for piston-engine aircraft.

"In proposing the new regulation, FAA cited the growing numbers of high performance aircraft using the airspace below 10,000 feet MSL where virtually all VFR (visual flight rules) flying is done, as well as about half of all IFR (instrument flight rules) flying. The proposed rule is designed to promote the safe separation of aircraft in this airspace by giving pilots more time to 'see and avoid' other air traffic which is the basis for all VFR flying."

Pilots in our fighter branch immediately took exception to this proposal because certain USAF aircraft cannot be safely maneuvered at 250 knots unless gear and flaps are down. We assume that the final FAA Regulation will contain fine print which will except the hot ones.

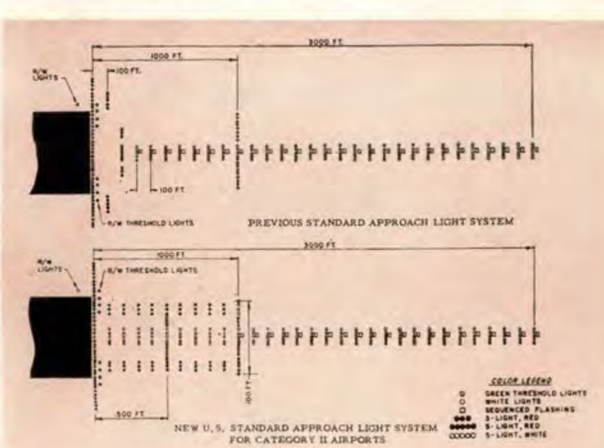
APPROACH LIGHT REQUIREMENTS FOR "CATEGORY II" AIRPORTS. The FAA has adopted a new U.S. standard for approach lighting at "Category II" airports. Category II airports are those at which a pilot can land an airplane when the ceiling is as low as 100 feet and the visibility is as low as 1200 feet. Military pilots still have to abide by the minimums specified in their governing regulations but they should all be very familiar with this new specification.

"Only the last thousand feet, nearest the runway, of the 3000-foot approach light system is modified by the new standard which calls for the addition of red light barrettes on either side of existing white centerline lights. Also, a red and white crossbar 500 feet from the end of the runway has been added, as well as white centerline lights at 100 and 200 feet from the runway threshold.

"The new standard eliminates the red 'wing' and 'terminating bar' light barrettes now located 100 and 200 feet from the runway threshold. Also eliminated are the sequenced flashing lights in the last thousand feet of the system. Sequenced flashing lights will continue to guide pilots from the 3000-foot outer limit of the system to the 1000-foot mark where the non-flashing white centerline lights and the red light barrettes on either side will indicate the distance of the runway threshold.

"Adoption of the new standard followed extensive testing of several approach light systems suggested by member countries of the International Civil Aviation Organization (ICAO). These tests indicated that the new system gave better visual guidance to landing pilots than the existing standard approach light system which has been used for the past 15 years. The new system was adopted as an ICAO standard in August 1966.

"Dulles International Airport is the only U.S. airport presently equipped with the new system. Other airports designated for low-visibility operations will be retrofitted as early as practicable." ★



HOW

Maj Roger Budd, Jr.,
Directorate of Aerospace Safety,
and
Mr. D. M. Kelly,
ARINC Research Corp.,
Annapolis, Md.

A technique for predicting a potential accident based on aircraft operations and failure of components prior to the occurrence of an accident would be invaluable to the Air Force. Although the idea is not new, previous efforts to invent an accurate crystal ball from which such predictions could be made have been compared to the alchemists' attempts to create gold.

The Air Force is not in the business of alchemy; it is in the business of operating aircraft, and to be effective in this activity it must continue to investigate new techniques for identifying safety problems and initiate actions aimed at *preventing* aircraft accidents. Just as alchemy evolved into the science of chemistry, one significant achievement in the safety prediction area has resulted from a feasibility study conducted by the ARINC Research Corporation, under a USAF contract.

The feasibility study was recently completed. It utilized two months of F-106 data hand-collected at George AFB. Thus far, only subsystem discrepancy has been considered in quantifying or measuring the effect of a subsystem malfunction or failure in terms of causing an accident. Using much of the system and reliability engineering techniques developed and proven in missile and launch vehicle analyses, the program thus far has demonstrated the feasibility

SAFE ?

of processing pilot reported discrepancy data and AFR 66-1 maintenance data to arrive at safety measurements. Although the method is still experimental, a follow-on program has been initiated to make actual safety measurements of selected aircraft.

The scope of this measurement technique is presently limited to the effects of subsystem malfunction with respect to mission phase. (For instance, the effect of loss of lube oil pressure during landing is less significant than during takeoff.) However, this approach is unique in that it evaluates these malfunction effects in quantitative terms.

The objective of this effort is to determine the relative significance of events to flight safety. An example of the kind of question that could be answered by such analysis is: Are three AC-DC power failures experienced in a month's operation of more, the same, or less importance than one flameout? The answer to this question would be available from the new analysis technique even though the squadron experienced no accidents. Maintenance allocation, modification funding or operations level could then be established based on the frequency of occurrence and the importance of events.

Very few primary malfunctions occur with identical frequency (this is not to be confused with secondary malfunctions which may accompany a primary malfunction). Additionally, each malfunction mode has a unique effect on aircraft safety and may vary depending on the type of mission and mission phase. Normally, malfunctions are classified as "safety of flight" or "not safety of flight." In reality, virtually all malfunctions have or could have some effect on flight safety. These effects can be thought of in terms of the probability that a given malfunction during a particular mission phase will result in an accident. Loss of a wing will always result in an accident (probability of accident given the loss of a wing = 1), the failure of a drag chute to deploy has the probability of resulting in an accident of less than one (although greater than zero).

Some apparently unimportant failures may have more significance because of their frequency of occurrence. For example, the attempt to get a head in the toss of a coin where the probability of getting the head is .5 for each toss. The probability of getting at least one head in two tosses is .75, in four tosses is .937, and in seven tosses is .993. Therefore, a malfunction that would cause an accident only 50 per cent of the time, has a 99.3 per cent chance of causing an accident at least once in the next seven times it occurs.

A program to make such measurements based on the malfunction occurrence rate is being established within the Air Defense Command. Data obtained from their Interceptor Sortie Evaluation System (ADCM-66-28) will be processed by specially designed computer programs to determine what events are occurring for each mission phase and what the effects of these occurrences are. The F-106 was selected for this initial analysis. This program encompassing the joint participation of ADC, AFLC, SAAMA and ARINC Research will analyze malfunction occurrence, duration and effect data for each sortie flown. These periodic analyses when compiled over an extended period of time will form a baseline from which adverse malfunction occurrence trends and flight safety problems may be more readily identified.

Computer outputs would identify unacceptably high trends of malfunctions, and action could be taken "before the fact" in cases having high safety risk. Potentially this technique could rank flight operations and specific missions in terms of accident potential. Comparison could be made of safety vs. cost for modifications, operations or maintenance changes, even alternative aircraft designs, and could affect pilot selection.

Safety of flight prediction will eventually require that data be automatically recorded during flight. It is anticipated that when Airborne Integrated Data Systems (AIDS) become an operational reality, they will supply the flight data required.

This effort will not replace present Air Force safety programs, but it is intended to provide more timely and objective assessments of the flight safety status, so that accident prevention measures can be based on trends which normally precede increasing accident rates. It represents a systematic approach to answering the question, "How Safe . . . ?" ★

JUICING THE...

Alton E. Justice, Aerospace Safety Engineer,
Lockheed-Georgia Company

When an explosion occurred during routine maintenance several men died and a multi-million dollar aircraft burned. Prevention of accidents such as this was one of the objectives in fuel system design for the C-5A.

Aircraft fuel system accidents have cost lives and enormous dollar losses. Despite concerted efforts to minimize the hazards inherent to aircraft fuels and fuel systems, the danger still persists. Even though rigid requirements have been established for the design, operation and maintenance of fuel systems, accident files contain many histories of fatal accidents. Aircraft are destroyed by fire during servicing and maintenance; wings are ruptured during fuel tank tests; explosions occur from lightning strikes, electrical malfunctions and fuel leaks; fuel contamination, icing, system malfunctions and improper procedures cause engine failure, personnel are overcome by fumes while working in fuel tanks; and the aircraft is always exposed to a fire hazard in a crash landing. In almost every case the end result is catastrophic—serious or fatal injuries to personnel and destruction of the aircraft.

The problems with aircraft fuel systems have magnified and multiplied as the environmental extremes of aircraft operations have been extended and more sophisticated fuels developed to meet new requirements. Demands for higher performance and longer range have increased the fuel quantity requirements to mammoth proportions.

Of the many factors to be considered in the design, production, operation and maintenance of an aircraft fuel system, the problems mentioned dramatically point out the importance of safety as a factor in design, operations and maintenance.

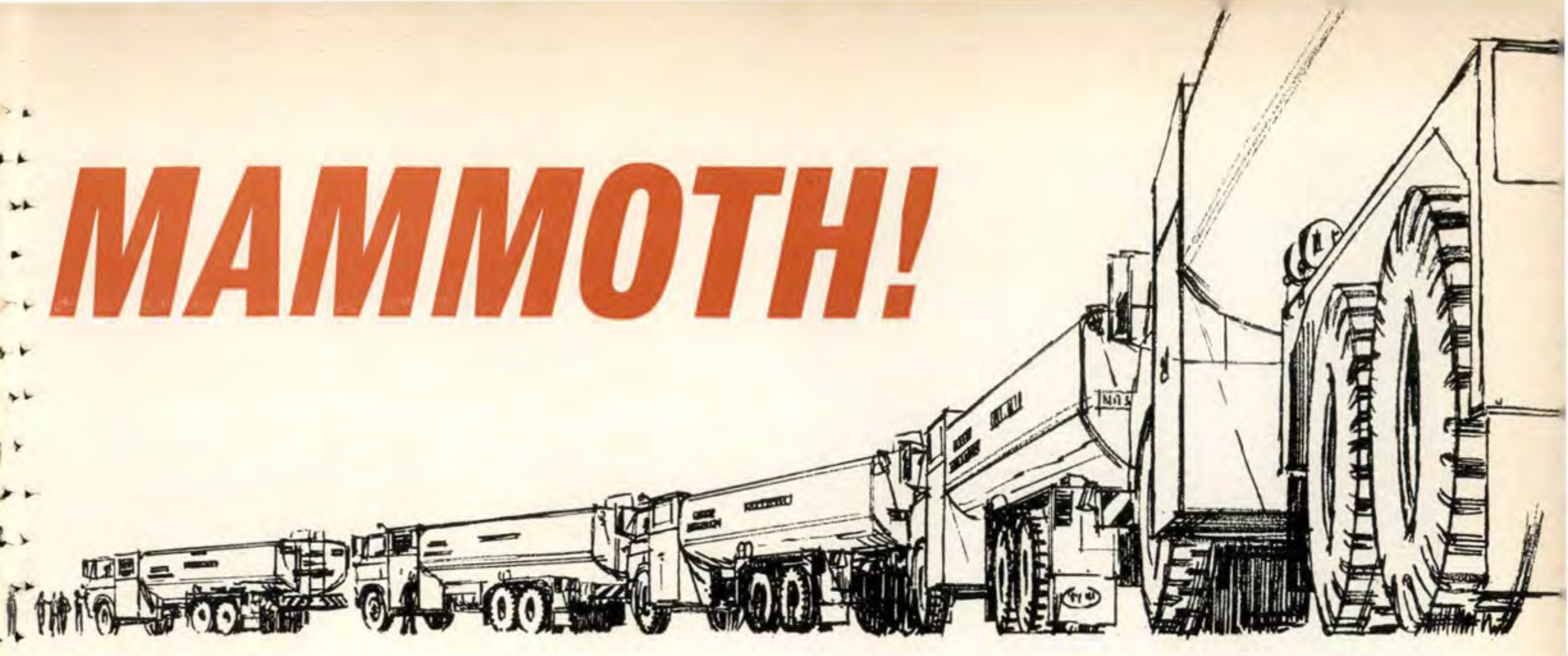
Design safety has been applied in the C-5A to a greater degree than in any previous aircraft. The fuel system design progressed through trade studies, preliminary and critical reviews, system safety group meetings, fault analyses, safety analyses, and a myriad of other efforts to develop the best system possible. The combined efforts of designers, safety engineers, and other associated personnel have produced what is believed to be the safest possible fuel system for a modern aircraft.

The C-5A will have a maximum gross weight (2.25g) of 764,000 pounds; must operate to high altitudes and in temperature extremes of —65 to +135 degrees; deliver a payload of 100,000 pounds 6325 miles, and be capable of fast turn-arounds. To accomplish this requires a 49,000 gallon fuel capacity. To fully appreciate the size of the fuel tanks, compare them with ten refueling trucks or more than five railroad tank cars. The fuel alone in the C-5A weighs more than the C-141 Starlifter at maximum gross weight. You can readily see that the fuel system on the C-5A presented an unprecedented challenge to the designer.

A look at the basic fuel system shows that fuel is carried in 12 integrally sealed wing tanks. Four of these are designated as main tanks, four as auxiliary tanks and four as extended range tanks. The tanks are vented by open lines which terminate in sump boxes in the outboard main tanks.

The system provides for feeding the engines, supplying the APU's, ground refueling, defueling, aerial refueling, jettisoning and tank to tank transfer. For all normal flight operations, fuel is supplied directly to each engine from its corresponding main tank. Auxiliary and extended range fuel is continually transferred to the main tanks. For emergency operation, fuel may be furnished

MAMMOTH!

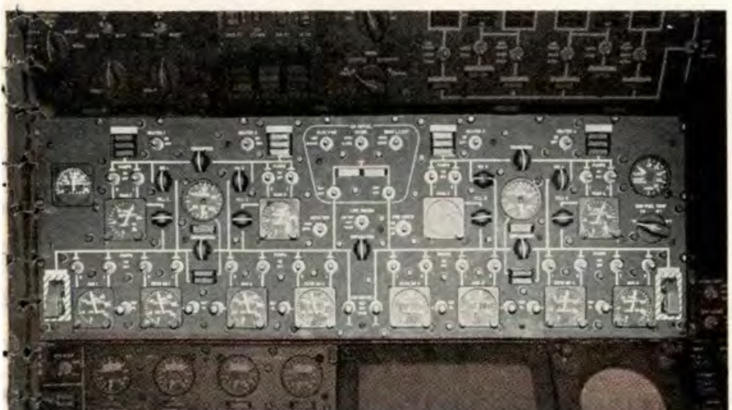


to the engines directly from the auxiliary or extended range tanks through the cross-feed system.

Refueling is accomplished through a single point system designed for pressure refueling of any or all tanks by pre-selection of individual tank quantities. The aircraft can be defueled through the single point refueling adapters by use of the aircraft boost pumps. Aerial refueling hardware is compatible with the KC-135 tanker. Fuel jettison can be accomplished by use of the tank boost pumps through two jettison masts located in the trailing edge of the wing.

Controls and instrumentation for operating and monitoring the complete fuel system are on the fuel management panel at the flight engineer's station. Provisions are also included in the system for fuel filtering, filter de-icing, and draining condensate from the tanks.

C-5A fuel control panel located at flight engineer's station.



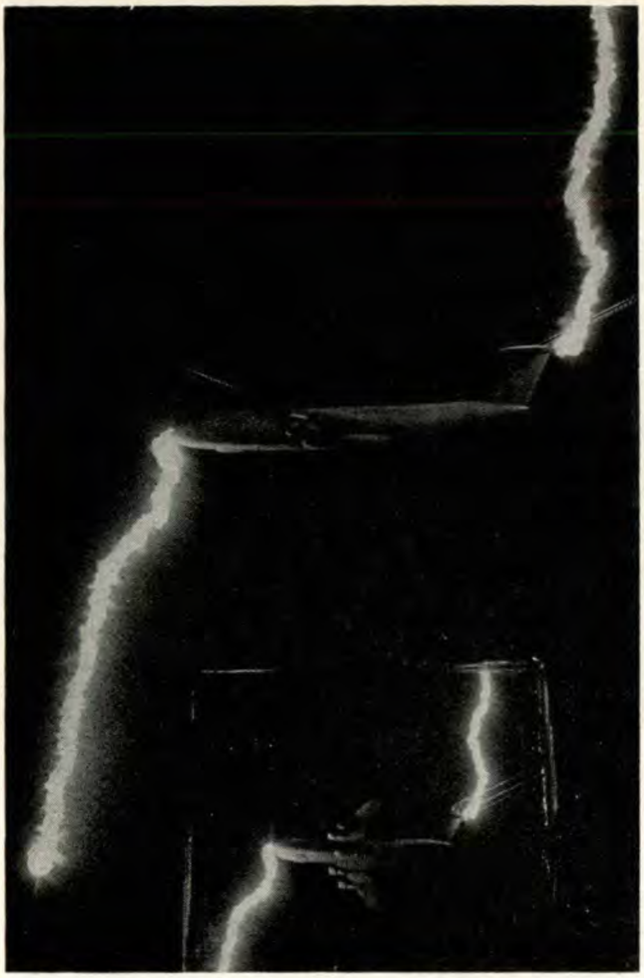
SIMPLE DESIGN

A basic safety criterion in designing any aircraft fuel system is simplicity. The C-5A fuel system is designed with the fewest components possible consistent with the demands on the system. The lines, fittings, and components required for pressure refueling, fuel jettison and fuel transfer are common to all functions. Fuel management is simple and straightforward. All main tanks have an equal volume of 3625 gallons, each of the auxiliary tanks contains 4625 gallons and each of the extended range tanks holds 4000 gallons.

Layout of the fuel panel provides easy and accurate control with minimum attention from the flight engineer. Tank arrangement and normal fuel management are such that the center of gravity will remain within acceptable limits without close monitoring. The fuel valves are "plug-in" type making removal and installation simple and "Murphy-proof." In the same manner, the fuel boost pumps can be removed and installed from the lower surface of the wing without draining or entering the tanks. The vent system is simplicity deluxe with open lines completely devoid of valves or moving parts.

PROTECTION FROM CONTAMINATION

Fuel contamination is always a matter of concern to a flight crew. Water, ice, micro-organisms and foreign objects are some of the major culprits. The C-5A uses a unique (and revolutionary) concept for water removal in the fuel system. Continuous inflight removal of water is accomplished by numerous ejectors (solid state pumping devices with no moving parts) installed at strategic locations in each tank. The ejectors are operated from tank boost pump bleed flow with discharge through a common line in the vicinity of the boost pump inlets. In the main tanks the residual water is mixed with the



Lightning strike tests. Photo shows discharge striking aft bullet in T-tail. Mirror view below.

fuel and subsequently fed to the engines. Besides this continuous water removal, manual drain valves are provided for drainage of tank condensate. The prompt removal of water also helps eliminate the microbiological problem. Fuel heaters located in the engine fuel lines de-ice fuel. If the fuel filter downstream of the heater becomes clogged with ice, fuel will flow through a bypass line, turning on a warning light. Turning on the fuel heater will eliminate the icing.

Another design requirement for the C-5A fuel system is that the failure of a single component shall not degrade system performance below acceptable levels. Consistent with this approach, redundancy has been built into the system. Dual boost pumps, each capable of providing the required fuel flow, are installed in each tank. For additional safety the pumps are wired from separate electrical busses. If both pumps should fail, it is still possible to provide engine feed (by gravity) using the engine-driven pump. A "negative G" capability well in excess of anticipated exposure is provided by gravity-sensitive, pendulum-type inlets on the scavenge ejectors which supply the pump sumps. Each tank level control valve has a single shut-off poppet actuated by two sets of "muscles," that is, two diaphragm or piston chambers connected in parallel with control floats to operate the poppet. The two circuits are completely independent and single diaphragm or float failure will not prevent valve closure. In addition, solenoids can be used to raise each float independently. The solenoids are powered from separate AC busses. Isolation and cross feed valves are arranged to provide parallel flow paths. Fuel ejectors have a dual flow supply.

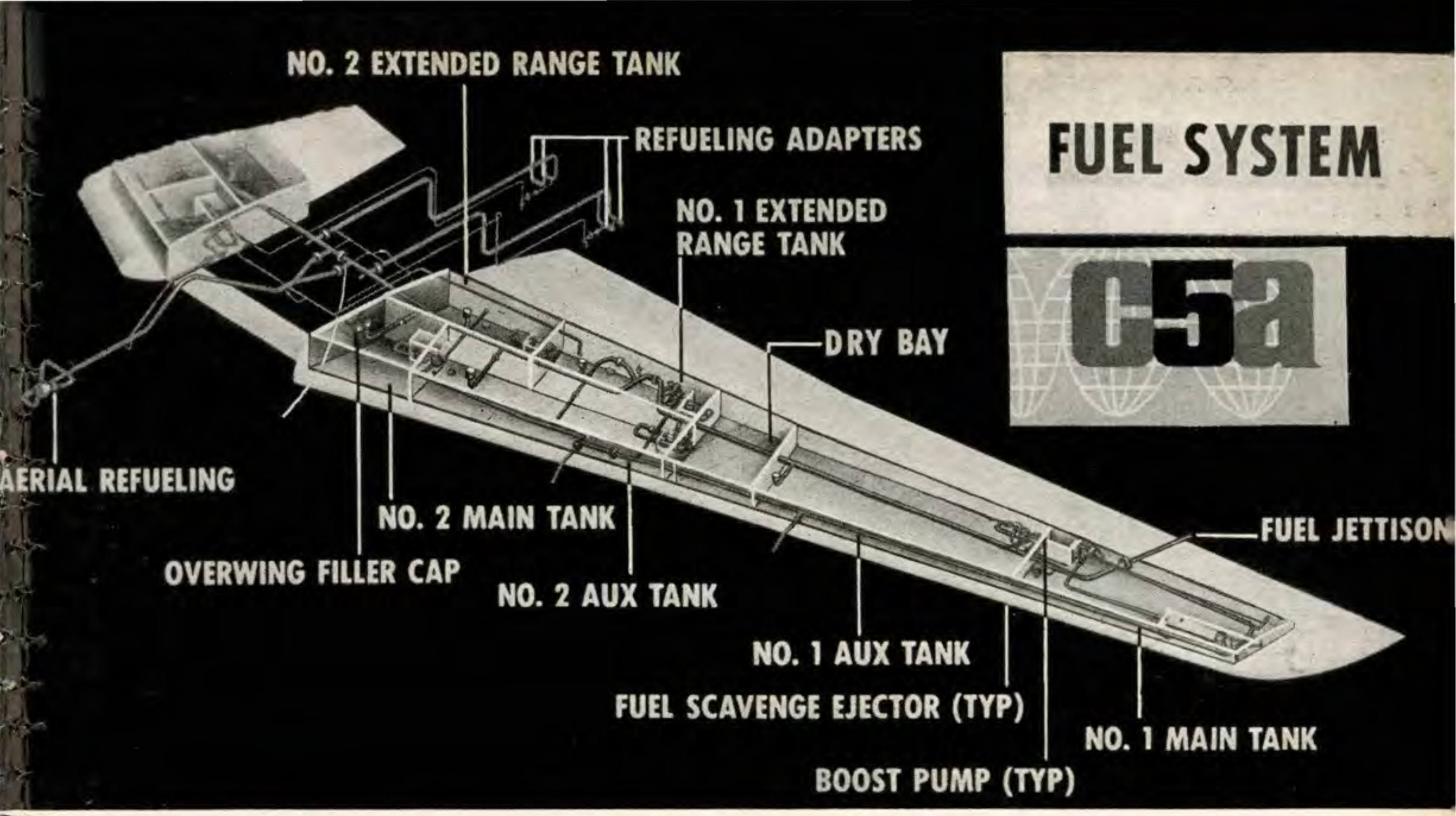
LIGHTNING PROTECTION

The latest state-of-the-art in lightning protection was applied to the C-5A fuel system. The Lightning and Transients Research Institute studied the design and recommended the best way to protect against lightning strikes. Some of the design features incorporated to protect the C-5A from lightning strikes are:

- Location of the vent box with its flush-mounted outlet well inboard of the wing tip.
- Flame arrestor mounted in the vent opening.
- Adequate bonding of all structure.
- Skin thicknesses in excess of .080 inches in all areas of the fuel system to prevent burnthrough. Access plates which do not meet the minimum .080 thickness have been designed for equivalent protection.
- Design of all fuel tank access openings to prevent arcing inside the (fuel) tanks. Special attention was given to structure discontinuities that might allow arcing.
- Fuel tanks are not located within the outer eight feet of the wing—where the lightning strike potential is greatest.
- Plumbing and wiring have been routed so as to eliminate "arc path potentials."

MAINTENANCE AND SERVICING

Eliminating accidents associated with maintenance and



FUEL SYSTEM

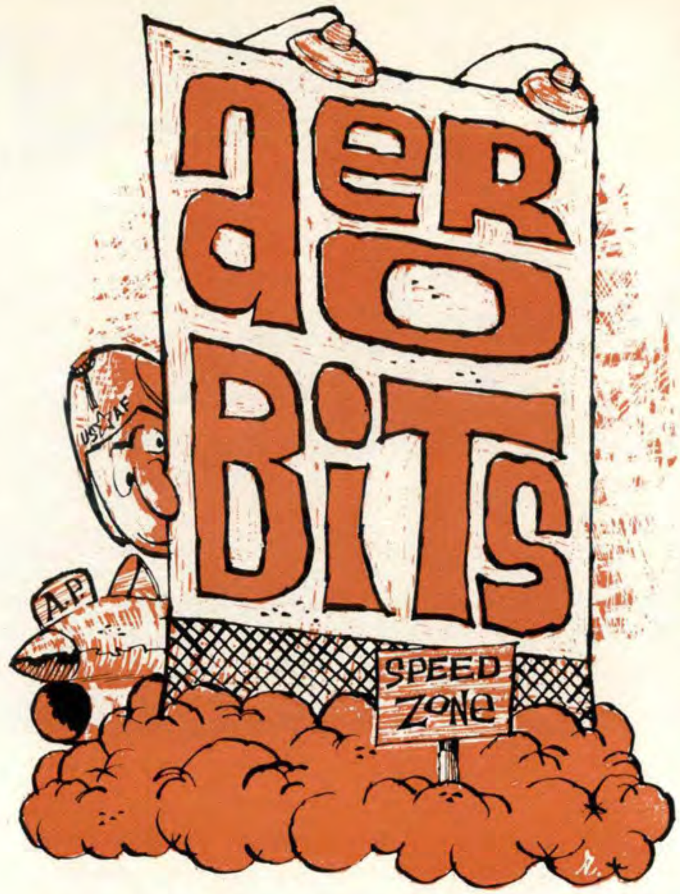
servicing of fuel systems received considerable attention in the C-5A design. As human factors were involved to a large degree, every effort was made to provide a "Murphy-proof" design. One of the serious problems on previous designs has been rupturing of fuel tanks during testing. The C-5A provides an effective test kit that will prevent damage to the fuel system from a positive or negative overpressure during tank tests. Other features include restraint devices for the safety of personnel working on the wings (a slip would mean a long fall) and optimum location of access openings to provide easy tank entry and maximum safety for men working inside the tanks. Requirements for tank entry have been reduced by using plug-in components such as valves, fuel quantity probes and boost pumps. And the improved reliability of the plumbing and tank sealant should further reduce the need for entering fuel tanks. Refueling operations are as simple and foolproof as can be devised, with the refueling adapters located for easy access. Proper lighting for night operations and adequate electrical ground connections are provided.

There is considerable safety inherent to the basic design of the C-5A. All fuel is carried in the wing which, at the wing root, is 25 feet above the ground. Fuel spillage in a survivable crash is minimized because of the high wing and the rigid structural design. The most susceptible portion of the system would be the outboard tanks which contain the smallest quantity of fuel and are widely removed from the aircraft fuselage. Additional safety is provided during takeoff and landing by pressurizing only the engine feed lines from the main tanks.

As has been pointed out, the C-5A exemplifies the latest in the state of the art. Rapid progress is being made in the development of better and safer fuel systems. Emulsified and gelled fuels, crash resistant tanks, improved fire detection and extinguishing systems, and use of plastic foam material in fuel tanks are a few of the projects under development. As these new ideas are proven, careful analyses will be made to determine their applicability to the C-5A.

This is but a brief preview of the efforts which have gone into the design of the C-5A fuel system. A team of highly qualified and dedicated engineers has worked thousands of manhours to design and produce a fuel system that will function *efficiently* and *safely*. The design of this system in combination with proper operation and sound maintenance practices will go far toward eliminating the type of accidents which have been so costly in the past. ★

Mr. Alton E. Justice, author of the article above, joined Lockheed-Georgia in April 1966 with safety engineering responsibilities for the propulsion and environmental systems in the C-5A. He had previously completed a 24 year career with the Air Force. A veteran pilot with over 10,000 flying hours, he has attended USC's Flight Safety and Advanced Safety Management courses and has eight years of safety experience.



SLIPPERY BUSINESS. The contributing causes in one of last winter's loss of control accidents are worthy of a review by all flying and support types.

- Runway snow removal was inadequate.
- Fire department personnel did not include abnormal edge-of-runway conditions. The RCR rapidly deteriorated toward the edges of the runway.

Military snow removal equipment should be controlled by a single agency so that all resources can be used when necessary.

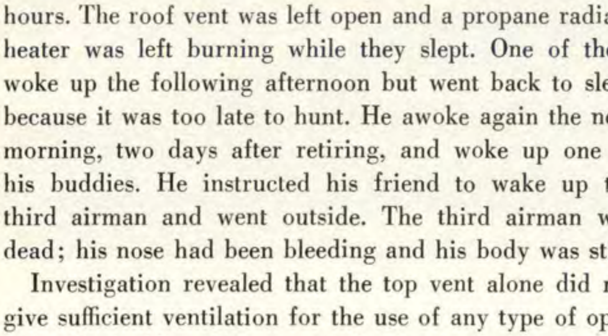
Runway condition readings should be made by rated officers whenever possible.

ASPHYXIATION IN A CAMPER. Three airmen on a hunting trip retired in their camper trailer at about 2100 hours. The roof vent was left open and a propane radiant heater was left burning while they slept. One of them woke up the following afternoon but went back to sleep because it was too late to hunt. He awoke again the next morning, two days after retiring, and woke up one of his buddies. He instructed his friend to wake up the third airman and went outside. The third airman was dead; his nose had been bleeding and his body was stiff.

Investigation revealed that the top vent alone did not give sufficient ventilation for the use of any type of open flame heat. Also, the propane heater is clearly marked with warnings, instructing the user to insure that proper ventilation is present. The inside instruction states, "Do not use while sleeping."

Sleeping in small quarters or confined areas with heaters operating offers two dangers:

- Injury or death by carbon monoxide poisoning.
- Injury or death from oxygen deficiency as is apparent in this case.



YES SIR! READY TO START ENGINES. How many jet engines are started each and every day? A heck of a lot, if we include the entire world. How many times is the proper pilot-ground crew coordination made for these engine starts? Hopefully, the answers to these two questions are the same. Experience, however, tells us that these numbers will not be the same. It has been my observation that lately the imbalance of these two numbers is getting greater. So what? Here's a true story that might answer "So what?"

For most it was just another day on the flight line, but for the KC-135 crew involved it was an important training mission. The preflight was completed up to engine start and over-all crew performance so far was good. As part of this training mission an alert start was to be made to include a cartridge start on Nr 4 engine.

The flight crew pressed on with the checklist items in the Starting Engines checklist. Item 6 was reached and the pilot called "Ready to start engines?" No reply from the ground. Another "Ready to start engines?" Again, no reply. A third time, in a little firmer voice: "Ready to start engines?" Rapidly a reply came through: "Yes sir! Ready to start engines."

The pilot then hit the cartridge start switch and started Nr 4 engine. RPM was run up to 90-93 per cent, and the remaining engines were being started when up the crew ladder into the cockpit came a very disgruntled ground member. "Sir, do you realize you just started Nr 4 while we were latching its cowling?" It was a surprise to the pilot for he thought the ground crew was "ready to start engines."

The *proper* ground crew response is *not* "Yes Sir! Ready to start engines," but rather "Chocks in place, engines clear, fire guards standing by." In fact, in this instance it had been the eager, young navigator who said, "Yes Sir! Ready to start engines." He thought the pilot was wanting him to respond, and so he did. Actually, the ground crew had said nothing. Where the blame is placed in this incident is not important. It is rather the moral of the story that is important. Incorrect responses by either ground or flight crewmembers can lead to trouble.

As a ground crewmember, how many times have you found it easier just to say "Yes Sir!" rather than the required response? If you find yourself doing this you may be setting yourself up for an incident just like the one above.

As a flight crewmember, how many times have you not insisted on the correct response for all the checklist items? You too may be asking for trouble, not only for yourself, but possibly for others too.

The proper responses are spelled out in the tech order and once learned they are easy to use. As a ground crewmember your knowledge and *use* of the proper responses can literally keep you from getting your fingers burned. As a flight crewmember, you owe it to yourself and your fellow crewmembers to know and insist on the proper responses to all checklist items.

Maj Richard C. Swift (AFETR)
Patrick AFB, FL

ACE. The Commander, Fifteenth Air Force, has a program that certainly merits dissemination by all possible means to the maximum number of our people. It's a real ACE (Accident Cause Elimination).

The goals of the ACE program are to insure that everyone directly associated with aircraft and maintenance operations is thoroughly briefed on the lessons learned from past accidents, and to insure that every conceivable effort is made to prevent accident history from repeating itself.

The ACE program, initiated in January 1966, consisted of a monthly letter highlighting a different area of vulnerability. Inadequate supervision of aircrew training and operations, poor technique in flight, inadequate aircraft maintenance, and poor technique on the ground were but a few of the areas units were required to examine. The ACE program in 1967 has a still newer approach. Now, instead of a monthly area of vulnerability, selected accidents of similar characteristics are grouped for presentation each month. The August edition of the letter covers the history of the battles between aircraft and thunderstorms. It shows that aircraft, and the Air Force, are always the losers in every battle.

We have borrowed from them and present to you their correlated accident summaries to assist the commander who stated, "Use any media you desire, but get this

message through to your people loud and clear: STAY OUT OF THUNDERSTORMS and avoid their vicinity to the extent possible."

1957: Jet bomber tried to top line of thunderstorms, pilot lost control; crew abandoned aircraft.

1959: Jet tanker entered known thunderstorm area, aircraft broke up; no survivors.

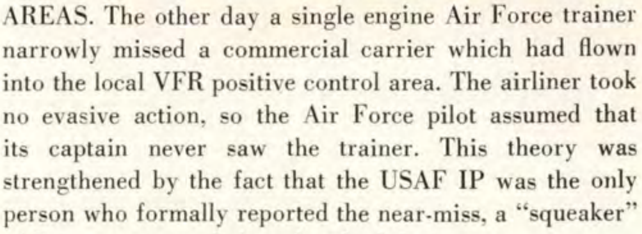
1960: Jet bomber flew into area of severe air turbulence, pilot lost control; crew abandoned aircraft.

1961: Jet trainer on VFR clearance entered a thunderstorm during penetration, pilot lost control, abandoned aircraft.

1966: Jet tanker attempted to take off between peak gusts, crashed; no survivors.

Each crewmember must read and apply the lessons learned from past crew histories if he wants to help lower the accident rate.

Lt Col Thomas B. Reed
Directorate of Aerospace Safety



WATCH OUT FOR INTRUDERS IN TRAINING AREAS. The other day a single engine Air Force trainer narrowly missed a commercial carrier which had flown into the local VFR positive control area. The airliner took no evasive action, so the Air Force pilot assumed that its captain never saw the trainer. This theory was strengthened by the fact that the USAF IP was the only person who formally reported the near-miss, a "squeaker" of between two and three hundred feet.

Stay alert; constantly clear yourself, even though you are in your own "private" training area. ★

FALLOUT

T-29 PROBLEMS

The narration about the T-29 and its problems with alternate static source lines (pg 26, July), presents a good case for professionalism, crew coordination and compliance with Dash One procedures. In the "what else is wrong?" situation, it appears to me that:

- The pilots should have noted the position of the selectors while accomplishing the check list—you said that.
- The copilot should have called a reject when acceleration was not up to standards—such as indicated on the Takeoff and Landing Data Card.
- A cross check of the pilot's airspeed indicator might have been the most logical immediate action, rather than a check of the remaining runway.
- Indiscriminate flicking of the static selector to the alternate position could result in some bumped heads and a bent bird if the aircraft is equipped with certain electronic auto-pilots. On those aircraft, the altitude control system gets its input from the pilot's (or copilot's) static system. Various forces therein combine to make a pressure differential approximating 50 feet in altitude and the auto-pilot will immediately correct to the new input with obvious results. Please advise your readers that most Dash Ones contain a "caution" advisory concerning this phenomenon.

The basic idea of checking this system is good; we probably have other systems in the same status.

Maj Charles W. Simmons
Chief, Flight Operations Br
Hq 2856 AB Gp (AFLC)
Griffis AFB, New York 13440

Please check page 28 of the August issue in which we made a correction to the original article as follows:

"We neglected to specify that the altitude hold function must be OFF when performing this check."

* * * * *

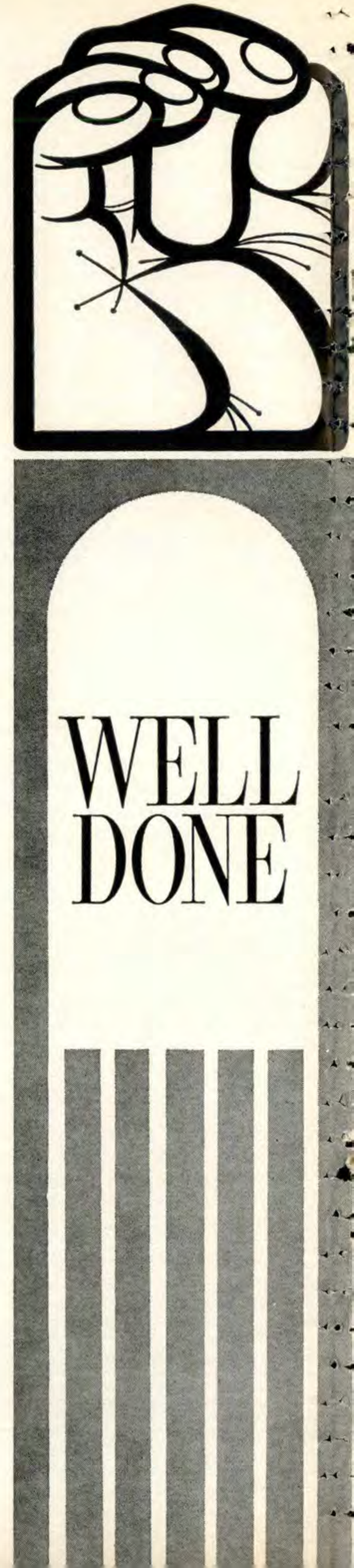
The following was sent to us by CWO W4 Adrian W. Bouldin, Western Communications Region, Hamilton AFB, CA.

TEN COMMANDMENTS OF FLYING SAFETY

1. Turn from thy appointed way hurriedly when instructed by him, lest ye find thyself making merry with thy fellow birdman's appendage, for the controller's sight encompasses that which thine eyes cannot see, yea, even unto thy wildest dreams.
2. When the controller sayeth unto thee with the voice of urgency "HOLD," holdest thou with the greatest expediency and without argument lest this be the final opportunity for thee to hold.
3. Should the voice from the air which is the controller's, clear thee for takeoff, go thou like the wind, for perchance there is a machine of flight on a short final which planneth to use the very surface upon which thou sittest in a very short time, yea, even unto seconds.
4. Should conditions surrounding thee be that which are known as IFR, ask him not for VFR takeoff, for should he allow it he will find himself in sore trouble with that agency (administration) known as the FAA, and the law of the land adjureth harsh penalties upon these happenings.
5. Speak unto him with a voice of honey. Use him as a brother lest he become excited, confused, loseth his wits, and give thee a right turn out when a left turn benefiteth the occasion, for lo, a controller loveth a calm, courteous pilot above all things.
6. While in his area, keep the controller informed well in advance of thy every intention, and believeth not that he readeth thy mind, for in spite of popular opinion he is human even as thee and me.
7. When thou hearest the words from the little black box sayeth "Unable to approve account traffic," beseecheth thou not from thy lofty position to change his decision for, lo, had not the traffic been there the words would not have been uttered; for he hath the eye of an eagle, and sees all without restriction.
8. When the clearance is of the VFR-On-Top type, stay ye from the proximity of thy brothers who are holding, for lo, the poor controller is sorely tried to explain to his IFR charges the presence of strange birds.
9. Asketh for instructions in a voice that is calm and clear so the controller will understand thy wants; confuseth him not lest he clear thee for final on "36" while clearing one of thy brothers for takeoff on "18."
10. Watch thou closely for all four-wheeled earthbound vehicles. They are numerous and unpredictable, yea, even as a whirlwind. Treat them with fear and respect while taxiing lest they charge upon thee with the speed of a lion and the fury of a tornado, for their drivers may be uninstructed in the ways of the birdmen.

Author Unknown

Thanks, Chief! ★



☆ U.S. GOVERNMENT PRINTING OFFICE 1967 301-211/2

MAJOR JACK C. FRANK

35 TROOP CARRIER SQUADRON, APO SAN FRANCISCO 96235

Major Jack C. Frank, C-130A aircraft commander, was engaged in a night airborne command and control/armed reconnaissance strike mission over enemy territory when the aircraft was hit by antiaircraft fire and tossed into an extreme nose-low, wing-down attitude.

While Major Frank was fighting for control of the aircraft, the auto pilot failed and he was notified by one of the loadmasters, A1C Gilbert S. Binsted, that a large fire was raging in the left wing near the fuel cells between Nr 1 and 2 engines. Major Frank immediately alerted the crew to stand by for bailout; however, he detected enough controllability to delay a final decision. Using full aileron deflection and asymmetrical power, he was able to achieve level flight at about 3000 feet AGL.

He then ordered more than 200 highly explosive and flammable flares jettisoned which was accomplished within 30 seconds. Leveling off at 7000 feet, he turned his attention to extinguishing the fire before the fuel in the integral wing tanks ignited. Airspeed was carefully increased to 230K by a shallow dive and use of differential power. The fire in the wing was finally extinguished and the navigator, Lt James D. Wilhelm, gave the heading to the nearest friendly airfield, Nahkon Phanom, Thailand, over 100 miles away. Major Frank then directed the copilot, Lt John R. Nelson, to take control of the aircraft while he and the flight mechanic, SSgt James L. Kenny, and the four loadmasters analyzed the damage. The enemy shell had severed the left aileron control rod, the wire bundle in the left wing, and the hydraulic lines from the Nr 1 and 2 engine-driven pumps. The latter resulted in the immediate loss of three of the four engine-driven hydraulic pumps. In addition, the severed wire bundle caused more than 100 circuit breakers to pop on the flight deck circuit breaker panels. Several minutes after the fire had been extinguished, the warning light for the remaining engine-driven hydraulic pump illuminated. The flight controls began to chatter and became stiff, indicating that the flight control boost system, essential to normal flight, was deteriorating. It was turned off.

After a total elapsed time of about 25 minutes, the aircraft approached Nahkon Phanom Air Base. The remaining hydraulic fluid was used to lower the gear. The flight control boost system responded slightly. Major Frank made a no-flap descent and blackout landing, to preclude any possibility of an electrical spark re-igniting the fire. The landing was accomplished smoothly and without incident. After disembarking, the crew discovered a six-foot diameter hole burned through the wing. Major Frank's calm leadership and heroic devotion to duty and the professionalism of the entire crew directly resulted in the safe recovery of a badly damaged C-130. Well Done!

CREWMEMBERS

Major Jack C. Frank
1st Lt John R. Nelson
1st Lt James D. Wilhelm
SSgt James L. Kenny
A1C Howard F. Harris, Jr.
A1C Gilbert S. Binsted
A1C Jack C. Taylor
A2C Raphael L. Delaney, Jr. ★

PREFLIGHT?