FEBRUARY 1959

FLYING SAFETY

UNITED STATES AIR FORCE

WHEN THE SKY THREW ROCKS

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VOLUME FIFTEEN • NUMBER TWO • USAF PERIODICAL 62-1

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Starting with a clean slate or clean aircraft is the correct approach.

THE EDITOR'S VIEW

Perhaps the greatest single source of improvement in safe flying is improvement in communication. Simple? Not by any means. To date, it has been one of the most difficult of problems faced by any industry. Because the Air Force is one of the largest organizations in being, the problem becomes even more complex. And because safety in flight operations involves not only the Air Force, but many of the largest industries and governmental agencies in the nation, our complexity is further compounded to astronomical proportions.

Many times, we in the Directorate of Flight Safety Research are unable to accomplish our jobs effectively, because you in the field do not furnish us with the ammunition we sorely need. Not bullets, but good old paper: Incident Reports, Unusual Occurrence Reports, EURs, URs, Operational Hazard Reports. All too often, information is received too late for effective action to be taken. Recently, three century series aircraft were lost as a result of flight control malfunctions. Once these accidents occurred, the using organizations began sending information concerning numerous similar malfunctions of flight control systems that had occurred prior to these accidents. If these incidents had been properly investigated and reported at the time of their occurrence, there is no doubt that some of these accidents could, and would have been prevented.

On another century series aircraft, a modification had been developed to improve its chances of successful barrier engagement. The modification schedule was not being accomplished rapidly enough. We could have used all the information that units in the field could supply regarding unsuccessful engagements to justify our insistence on greater production speed. Not one report was submitted, although four incidents were known to have occurred where the barrier did not engage the aircraft.

These are not isolated instances. In order to conduct an efficient, effective accident prevention program, we must have knowledge of trends. Help us help you by reporting anything and everything that affects the safety of our aircraft and aircrews.

Apologies and Kudos

. . . December issue of FLYING SAFETY erroneously lists Randolph AFB as recipient of a Flight Safety Award for the first half of 1958. This information is incorrect. Craig AFB received the cited award. Request that the next issue give due credit to Craig AFB. During 1958 that base has flown over 57,000 hours in T-33s with only one accident. Craig has flown over 105,000 hours in 599 days without a T-33 landing accident. The accomplishments of all pilots assigned to Craig during 1958 should not go unrecognized.

COMATC Randolph AFB, Texas

Kudos and apologies to the lads at Craig.

★ ★ ★

Forms 781

Here are a few excerpts from Letters to the Editor with reference to the article titled "Change in Form" published in November.

★ ★ ★

. . . These errors are all so obvious they seem intentional. The unfortunate crew chief who would bring a form filled out in this manner to our Forms Inspector would spend half the night correcting the discrepancies.

T/Sgt. Harold P. Mankenberg
28th Bomb. Wg, Ellsworth AFB.

★ ★ ★

. . . I can still hear the screams from the Form 5 Section when they record the time and from the pilot at the end of the month when he does not get his flying pay. "I flew from here to here on this date. Why didn't I get paid?" The first answer is, he didn't log his time on the form. The second is, he should have gotten his time in before the 20th if he wanted his pay by the first of the next month. I've worked close enough to the Form 5 Section to know that they have some real headaches in deciphering what pilots write on the forms.

1st Lt Eric G. Stone
6580th Fld Maint. Sq
Holloman AFB, New Mex.

★ ★ ★

. . . The Lieutenant must have goofed.

Maj. Clarence W. Brown
4AF Hamilton AFB, Calif.

★ ★ ★

. . . During my lunch hour, I was enjoying reading your wonderful magazine, but I almost gagged on my chow when I read your most informative article about "Change of Form" in regards to the many, many minor errors shown on your samples.

T/Sgt Frank J. Niess
1502d ATW (MATS)
APO 953 San Francisco

★ ★ ★

. . . Your reproduction of the AFTO Form 781, Part 1, indicates some errors that are probably screaming to be corrected by virtually every Form 5 Clerk in the country. Your article is very interesting to maintenance men and pilots. A little more detail, however, could have been given to filling out part I. This would benefit both pilots and the Form 5 clerks, in the long run.

M/Sgt James R. Thompson
307th Bomb. Wg. SAC
Lincoln AFB, Nebraska

★ ★ ★

. . . In glancing over your form samples I've discovered many discrepancies. I may have missed a few.

T/Sgt Elmer K. Koontz
3640th Flt. Line Maint. Sq
Laredo AFB, Texas

★ ★ ★

. . . The article "Change of Form" has been very helpful to pilots at this station. Keep up the timely information.

Lt. Col. H. O. Bordelon
FSO, Sacramento AMA, Calif.

★ ★ ★

. . . It is not easy for the Form 5 people to read your minds. Why don't you pilots help us a little more and cut out the excessive phone calls necessary to complete the Part I?

Hazell Scott
Flight Records Section
3800th Support Sq. ATC
Randolph AFB, Texas

★ ★ ★

. . . While reading your informative article, "Change of Form," I ran across the statement, "The Air Force has a new 'Scoreboard' these days, and maintenance men need pilots' help to fill it out properly." Don't get me wrong now. I'm not knocking the pilots, but after looking at the AFTO forms used in the illustrations, I believe we all need some help and a better knowledge of what is contained in T.O. 00-20A-1, dated 1 July 1958.

S/Sgt Homer Gray
3551st Flt. Line Maint. Sq
Moody AFB, Georgia

Check Page 25.

★ ★ ★

Instrument Approach Chart

I've read with much interest the article in the October issue entitled "Get It In a Package." The article, however, did not reveal a design discrepancy which has always been a pet peeve of most pilots.

In the article it is stated that "you need a book that will fit conveniently in the clip of your flying suit, or under the clip of your standard clipboard." Neither of these arrangements have ever been satisfactory. Placing the Instrument Approach Chart in the clip on the flying suit does not conform to the latest advice from physiological studies that recommend a minimum of head movement when flying instruments. In addition, lighting for the Instrument Approach Chart is usually not provided or is inadequate. The clip board is in the same category. It is usually balanced on the knee, propped up on the instrument panel or the windshield.

The Instrument Approach Chart must be considered as much an instrument as the altimeter, gyrosyn compass, clock, rate of climb, and so on, as it dictates altitudes to be flown, courses to follow, times to make good, rates of descent, and so on. So without an Instrument Approach Chart properly located and well lighted, the rest of the instruments are worthless.

A well lighted Instrument Approach Chart has been in evidence in some of the later and widely used types flown recently, like the C-121, C-97, C-124, C-131, C-133, C-130, T-33, B-57, F-86, F-84F and F-100D. Lack of a suitable place to prop the Instrument Approach Chart was apparent in an F-101 MTD attended recently. In my present assignment I have the opportunity to become acquainted with and fly the latest type of equipment entering this theater and have yet to observe a new design incorporating a provision for a permanent Instrument Approach Chart holder, and as the article states, the pilot is required to "juggle" his library aloft.

The pilot of the C-133 is forced to put the Chart on the control quadrant and the pilot of the C-130 can stuff the corner of the chart behind some sound-proofing material. In both cases, in these later types, it usually winds up on the floor, obscures an instrument or interferes with a control.

How many IPs have handed a pilot an Instrument Approach Chart when he is first checking out in a new aircraft and watched him fish around for a good place to lay it while he makes his letdown? In more than 11,300 hours of military flying, I've seen this chart precariously balanced in every place but the ceiling.

Automatic landing devices are still a long way from being an entity for everyday use and our most modern fighters, bombers, and transports are being equipped with OMNI and TACAN for which an Instrument Approach Chart is still required in our — to quote the article — "Black Box Air Force."

Proper consideration has not been given to cockpit layouts in new designs for a blank space as part of the instrument panel, with clip and light attached, to fix the Instrument Approach Chart in proximity to the instruments during descent.

We have only to check the records of accidents caused by misreading the information on the chart (or even reading the wrong chart) to agree that much can be done to improve our position in affording the pilot a suitable reference to his basic guide during an instrument letdown. It is recommended, therefore, that due consideration be given to the layout of a cockpit to provide a space for the miniaturized looseleaf Instrument Approach Chart.

Lt. Col. Samuel C. Burgess
4440th Aircraft Delivery Gp (TAC)
APO 10 New York, N. Y.

Can't argue that the problem exists. We've passed your letter to WADC for consideration.

The U. S. Air Force spends billions for good materiel, but all the money in the world won't buy good maintenance.

Many people do not realize it, but at any given moment of the day the United States Air Force has approximately 1150 aircraft airborne somewhere in the world. In the last sixty seconds, these aircraft have flown some 4750 miles. This is an air operation far in excess of any other air organization in the world. For example, the combined civil fleet of the United States represents something less than 1500 airplanes total. In the Air Force we cross the United States in a minute; in one hour we fly the equivalent of the distance to the moon, and to the sun in two weeks.

What are the costs in aircraft accidents that result from such operations? Since 1950, Air Force aircraft accidents have resulted in 5,599 aircraft being destroyed, 2,764 pilots being fatally injured, and 1,260 pilots receiving major, non-fatal injuries. These do not include any combat losses. This is the accident price that has been paid to train for the Air Force mission.

As you can see from Figure 1, the accident rate has steadily declined from 1921 to date. The rate is based on major accidents per hundred thousand hours of flying time. While the over-all accident rate is steadily decreasing, as we approach the ultimate figure of zero, our job becomes increasingly harder. In addition, the dotted curve here gives the fatal accident rate. While this rate is also declining, the curve seems to be leveling off. For the last three years the rate is three. This means that in 1956, with an accident rate of fifteen, and a fatal accident rate of three, one in five major accidents was fatal, whereas in 1958 almost one accident in three was fatal.

My purpose is to discuss in some detail our experience in the Air Force with all types of aircraft mishaps, major and minor accidents and incidents, with a view to isolating some problem areas for further consideration by maintenance people. Let's take a look now at the cause of our mishaps.

You'll note in Figure 2 that cause factors are generally broken down to Pilot, Materiel, Maintenance, Support and Supervision. Where our investigations were detailed enough, we may find maintenance to be involved in the

Materiel Minus Main

Colonel John A. Herrington, Chief, Research

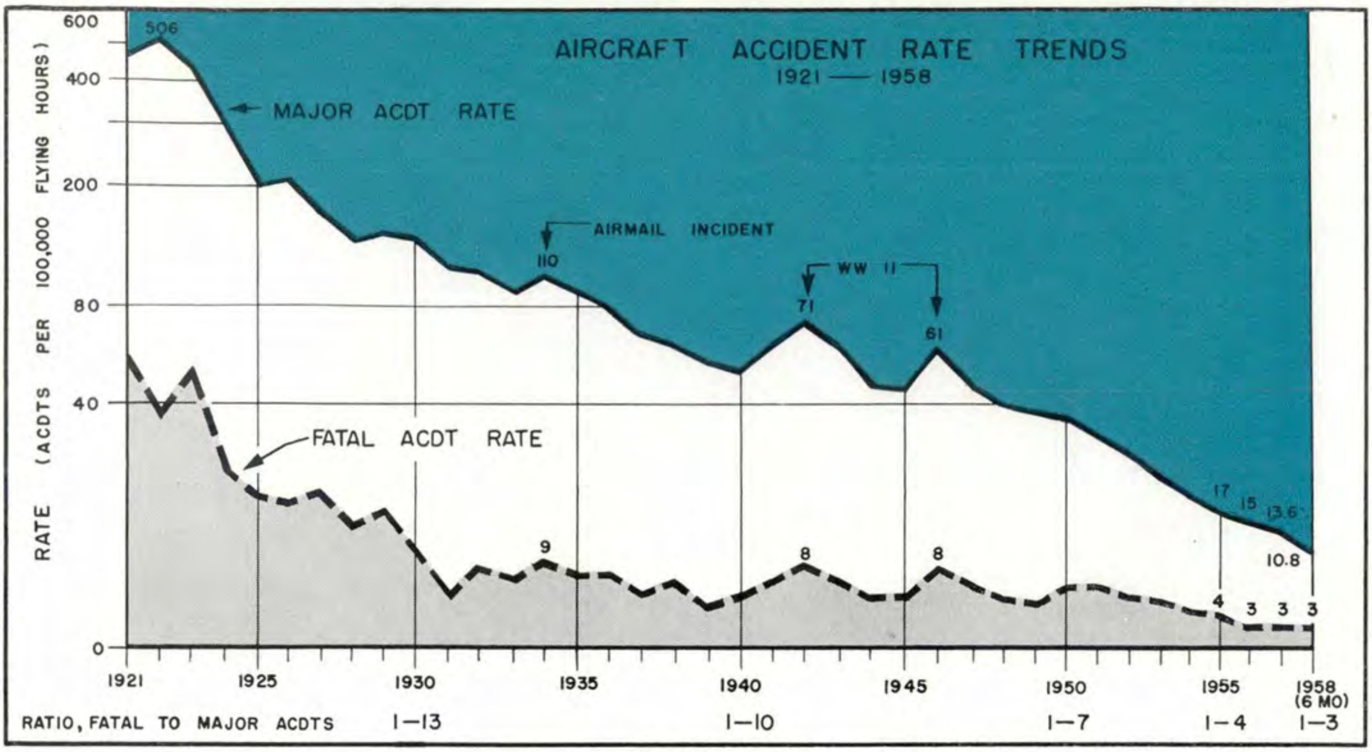


Figure One

tenance=Mishaps

and Analysis Division, Flight Safety Research

CAUSE	1954	1955	1956	1957	1958 (9 MOS.)
PILOT	49%	48%	44%	41%	42%
MATERIEL	23%	24%	26%	31%	32%
MAINTENANCE	5%	4%	4%	5%	5%
SUPPORT	1%	1%	2%	1%	1%
SUPERVISION	4%	4%	6%	5%	7%
OTHER	18%	19%	18%	17%	13%

Figure Two—Primary Causes of Major Accidents

failure, but in most cases, the evidence we need is lost in the crash. For our discussion, let's lump together all materiel failures and malfunctions and examine them from a maintenance man's viewpoint.

In order to examine our experience in detail, one should select a base period far enough in the past to insure that the cause for the mishap has been finally determined and all of the discussion back and forth is settled. I have chosen the period 1 July 1956 through 30 June 1957 as the base period for my statistics. During this period the Air Force experienced a total of 2638 mishaps. Perhaps an explanation of what constitutes the various types of mishaps is in order at this point. The difference between a major and a minor aircraft accident is in the number of manhours required to repair the damage, with the major accident being the most serious. To define an incident as used in the Air Force, let me give you some examples.

- The loss of canopies, doors and hatches in flight in which there is no other damage to the aircraft, and crewmembers are not injured.
- Hail or ice damage, lightning strikes and bird strikes, when no other aircraft damage results.
- Any mishap occurring on the ground when no flight was intended, such as an engine fire or a blown tire, while the ground crew is running-up or taxiing the airplane.

Figure three shows the breakdown of these 2,638 mishaps. In six per cent of the cases the cause was undetermined. This means that we found the pieces of the airplane on the side of the mountain somewhere, or that the pieces trickled down out of an overcast and we were never able to determine what happened. Also in this category would be those cases where airplanes just took off and were never heard of again.

In 46 per cent of the cases, unsafe conditions were the primary cause factor. An unsafe condition applies to materiel failures or malfunctions in the aircraft, or to conditions outside of the aircraft. I'll say more about this later.

In 48 per cent of the cases, unsafe acts were committed which were the primary cause of the mishaps. An unsafe act, of course, is that error by personnel which caused the accident or incident. This error could be in either omission or commission.

One further word about unsafe conditions and unsafe acts. It is extremely difficult to separate clearly the unsafe act from the unsafe condition, since each has a bearing on the other. An unsafe act may induce an unsafe condition or an unsafe condition can, in turn, induce an unsafe act. Here is an example:

Twice during this base period being considered, an experienced maintenance man changed the bomb bay tank boost pump in one of our aircraft and wound up with the hot wire attached to the ground. The resulting explosion destroyed the aircraft in both cases. Now it so happens that there is a block of these aircraft in the inventory that are not standard. In this particular block of aircraft the white wire attaches to Pin A, and the black wire to Pin B, which is directly reversed from the majority of the similar type airplanes.

In the maintenance instruction handbook it clearly spells out that you look at the tail number of the aircraft, and if you have one of these that has the reversed wiring, you should hook up the bomb bay tank boost pump in the manner outlined in the handbook.

Yet, twice during this one-year period an experienced mechanic—I might say a *too* experienced type—changed boost pumps exactly as he had changed many, many other boost pumps, and wound up with a hot wire attached to the ground and caused an explosion. This is an unsafe condition inducing an unsafe act.

The unsafe condition block of 46 per cent is actually 40 per cent materiel failure or malfunction, and six per cent miscellaneous. This, in effect, separates the airplane from its environment. The six per cent miscellaneous covers such items as communications difficulties, airfield hazards and so on, which are external to the airplane itself.

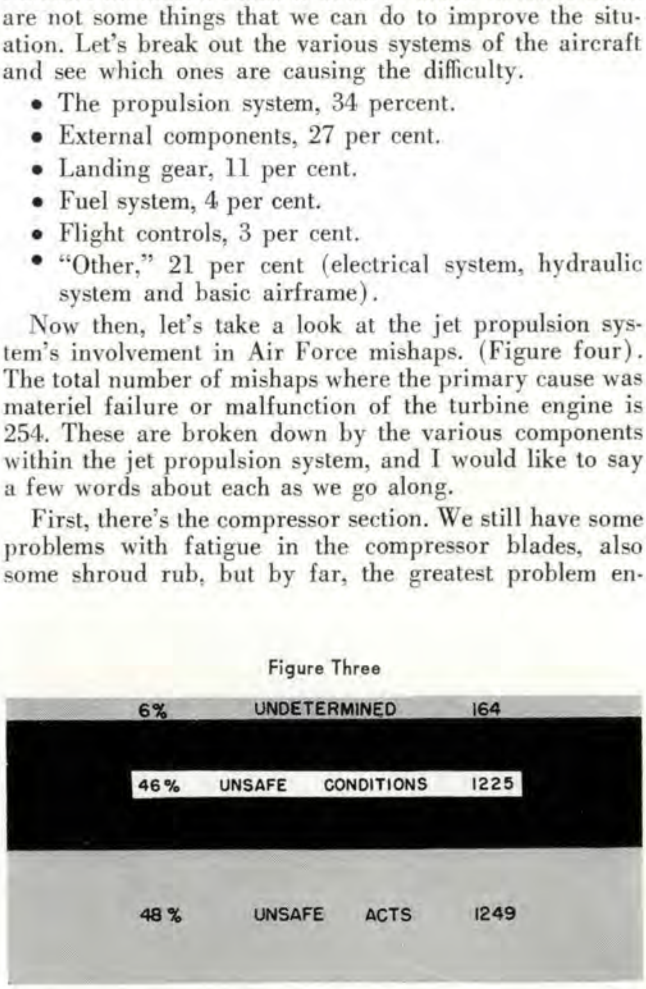
From here on, let's take the materiel failure or malfunction block and break it down in detail to see if there are not some things that we can do to improve the situation. Let's break out the various systems of the aircraft and see which ones are causing the difficulty.

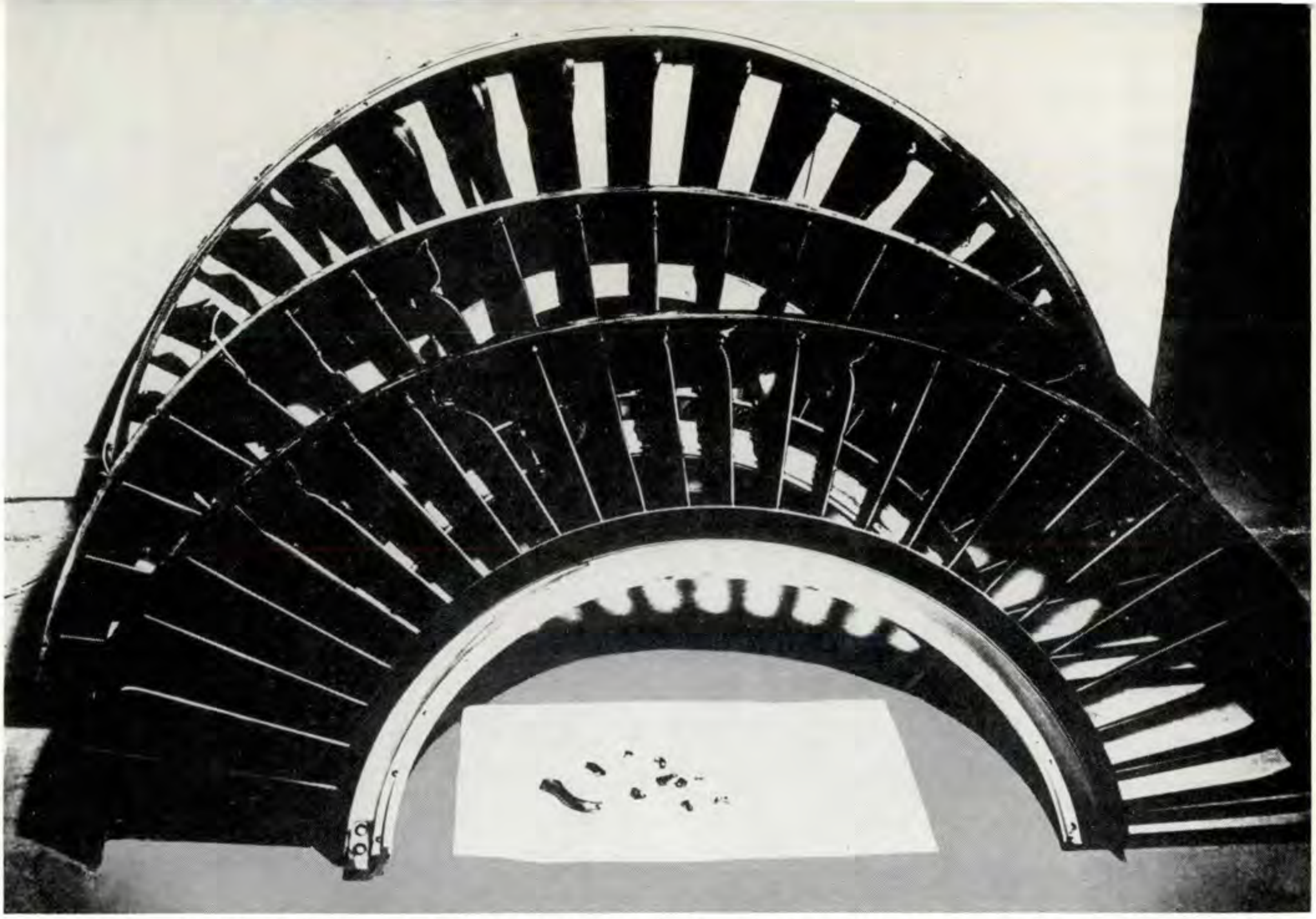
- The propulsion system, 34 percent.
- External components, 27 per cent.
- Landing gear, 11 per cent.
- Fuel system, 4 per cent.
- Flight controls, 3 per cent.
- "Other," 21 per cent (electrical system, hydraulic system and basic airframe).

Now then, let's take a look at the jet propulsion system's involvement in Air Force mishaps. (Figure four). The total number of mishaps where the primary cause was materiel failure or malfunction of the turbine engine is 254. These are broken down by the various components within the jet propulsion system, and I would like to say a few words about each as we go along.

First, there's the compressor section. We still have some problems with fatigue in the compressor blades, also some shroud rub, but by far, the greatest problem en-

Figure Three





Forty per cent of all jet engines received for overhaul suffer from foreign object damage—sometimes small tools.

countered with the compressor in our axial flow jets is brought about through foreign object damage to the compressor section. It is thought, in some circles, that foreign objects are mainly rocks and other debris picked up off the ground and ingested by the engine. This has not proved to be the case. Occasionally we do find some rocks or debris in our engines, in addition to tools or lunch buckets. By and large, however, the predominance of foreign object damage is caused by small screws or portions of access panels or latching mechanisms which are ingested by the engine after they've come loose from the duct or adjacent aircraft structure. Or, perhaps they were left in the ducts during assembly or maintenance. It has been revealed that out of all jet engines received by overhaul facilities, 40 per cent are suffering from foreign object damage. This is a tremendous expense to the Air Force in unscheduled overhaul of the engines and replacement of damaged parts.

The moral to this story to maintenance readers is obvious: Close attention to detail when working around the scoop can certainly contribute a great deal to the reduction of this foreign object damage.

The picture above shows an example of foreign object damage incurred when a mechanic left a pair of needle-nosed pliers in the compressor after checking a component of the engine. These are the stator rings of the first three stages of the compressor, and on the little sheet of paper in the foreground is what remains of the needle-nosed pliers. These parts were found in the compressor bleed valve after this aircraft was successfully landed. Despite considerable damage to the compressor, this engine ran well. The only manifestation was a slight power stall at 70 per cent rpm.

Next, let's take a look at the fuel system. Here we are talking about the high pressure fuel system for the engine not the aircraft fuel system itself. We have experienced two basic problems with the engine fuel system.

First, we have difficulties with fuel metering. Our fuel control requirements are such as to require close tolerances in many of its several systems or sub-sytems. Perhaps in our race for performance we are shaving these tolerances a little close.

The other big problem in the fuel system has to do with leaks throughout the basic engine fuel system itself, and these leaks seem to be centered in connections (connections of all kinds have their own unique leaks). Here are a few examples of what we're running into, in dealing with this problem.

One case was a burn-through on a jet engine which was caused by a fuel leak in the main fuel distribution system. The main fuel manifold comes around the engine just forward of the frame where the burn-through occurred, and right behind the cluster of fuel nozzles. There was a leak in the connection between the nozzle cluster and the fuel manifold which resulted in a burn-through of the engine at this point. This is a particularly insidious type of burn-through in an engine because, while in this case the burn-through was caused by a leak in the fuel line, we have other cases that look almost identical with the burn-through being caused by a misaligned burner can downstream of the fuel nozzle. A closer look at the engine high pressure fuel system shows the predominance of our problems centered around those engines having afterburners and the plumbing associated with the afterburner.

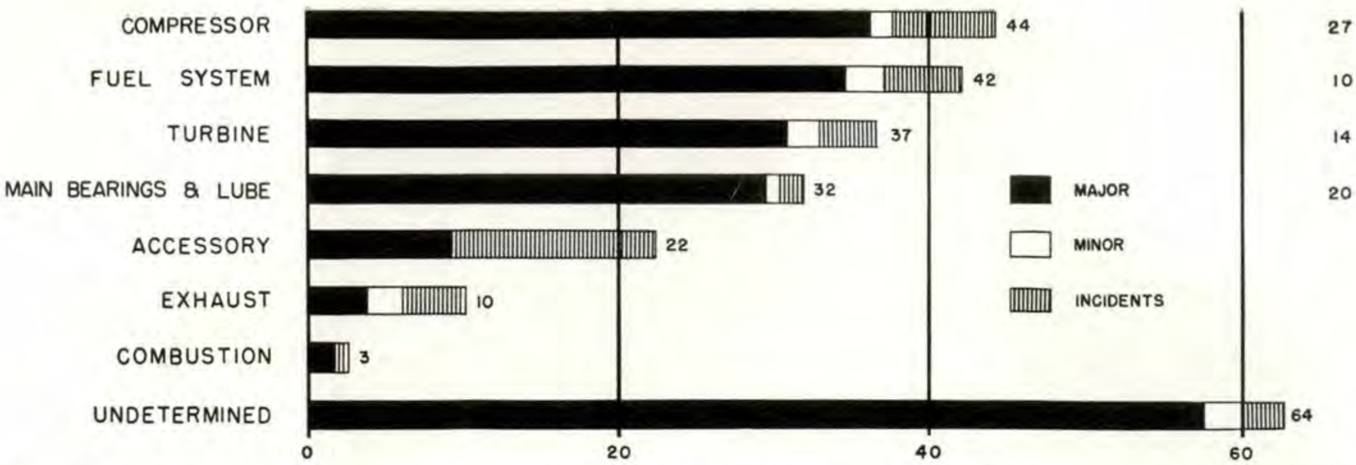


Figure Four—USAF Accidents/Incidents caused by materiel failure or malfunction of turbine engine—1 July 1956 thru 30 June 1957. Total 254.

There was another case involving the fuel distribution system on a jet engine. The system takes the fuel from a manifold around the aft frame of the engine and passes it through a series of 24 tubes called pigtails, because of their shape, and into the individual fuel spray nozzles within the afterburner. A broken pigtail results in jet fuel spraying out at this particularly hot section of the engine, and we have many, many fires and explosions resulting from this problem. Several points of interest for maintenance people appear here.

First, these pigtails are just not quite symmetrical in any axis. They cannot be reversed end for end or rotated 180 degrees around the longitudinal axis without resulting in a misalignment. Many times mechanics have reversed a pigtail or rotated it and forced the fitting to such a point that they could engage the first thread of the B-nut on the fitting. This results in the same condition that you and I have encountered in forcing a carburetor line on a Model-T Ford. We wind up with a stripped thread or a cross-threaded B-nut which later comes loose in flight, with disastrous results. Very close attention to the proper mating of these joints—and there are 48 of them around the aft section of this engine—is necessary during assembly. Proper torquing procedures must be followed to prevent leaks, and as an added safety feature make sure the B-nuts are safetied in the made-up and torqued position. Here is a real fertile field for maintenance people. I'll have more to say about the fuel system later. For now, let's pass to the turbine section of the engine.

The basic problem with the turbine section of the jet engine seems to center around over-temperature. The components of the hot section are getting too hot and as a result, are failing in service prematurely. The problem here seems to be the need for better methods of recognizing over-temperature conditions, such as instrumentation and some knowledge of what to do to correct the condition before the results are catastrophic.

Let's talk about the main bearings and lube system. The basic problem here is lack of lubrication. Either the airplane was not properly serviced with oil, or a leak developed somewhere within the system (some of those connections that we had trouble with in the fuel system are acting up again), or something plugged up the last chance screens or orifices within the high pressure oil system.

To continue with the various components, the next in order of importance is the accessories section. (See Figure 4.) This has to do with combustion starters blowing up on the ground, and some problems with reduction gear drives and constant speed drives. Under the next block, exhaust section, primarily some afterburner difficulties—hardware difficulties. Under the small section on combustion, this is mainly burner can difficulties.

And now we come to that big undetermined block of 64 mishaps. This means that we were unable to pinpoint the primary cause of the accident with sufficient confidence to place it in one of the other blocks up above. However, we didn't lose all of the results of the investigation concerned. We do know certain things—for example: of the 64 mishaps, 40 were caused by or had the manifestation of a flameout in flight, and 15 of these 64 mishaps were inflight fires or explosions. So as to put this in the proper persepective, we must take these 40 flameouts and 15 fires and explosions and put them up in the other sections—most probably they belong in the fuel system—so that we can say with a reasonable degree of confidence that the fuel system, the engine high pressure fuel system, is the Number One offending component section of the turbine jet engine and replaces the compressor.

Just one word about what this data represents to the Air Force. Notice the small figures at the end of the chart (Figure 4). These are millions of dollars involved; and the loss—compressor section, 27 million, fuel system, 10 million, turbine, 16 million, main bearings and lube, 20 million, undetermined and the other sections combined—add up to a total loss to the Air Force for this one-year period of 90 million dollars in destroyed aircraft. This is just to replace the hardware. This does not include such costs as training or the replacement of personnel who are irreplaceable.

Good maintenance is a result of good training and the right mental attitude of all concerned.

Materiel Minus Maintenance Equals Mishaps. ▲

• WELL DONE •

First Lieutenant

CHARLES O. COOGAN

3560th Pilot Training Wing, Webb AFB, Texas

★

Lt. Coogan was assigned as instructor in a T-33A. With his student he was flying Number Two in a two-ship flight. The mission was cross-country under instrument conditions. The weather was overcast with the tops extending to 31,000 feet. The two T-Birds were on top at 32,000 and the flight was normal until two minutes east of Vance VOR.

At this time an explosion shook the T-Bird aft section and was followed by complete power failure. Lt. Coogan stopcocked the throttle and decided against trying an airstart. With the loss of power his T-33 slipped down into the overcast and lost contact with the lead airplane. Vance tower was called, told of the emergency, and advised that a penetration and approach was being started. Coogan then asked for GCA assistance. Partial electrical failure now occurred and the navigational radio equipment was inoperative. GCA was unavailable so the DF was relied on for recovery. A partial panel DF letdown was made and the T-Bird broke through the overcast at 12,000 feet over Enid, Oklahoma. Lt. Coogan set up a flameout pattern and made a deadstick landing at Vance Air Force Base, without damage to the airplane.

The maintenance investigation revealed that there were broken leads between the micro switch which controls the emergency fuel solenoid. It is believed that the emergency system cut in at an altitude which would cause the explosion and flameout. Well Done, Lieutenant Coogan!

First Lieutenant

FRANCIS J. ADAMS

3640 Pilot Training Squadron, Laredo AFB, Texas

★

Lt. Adams was Instructor Pilot on a routine training mission in a T-33. Seven minutes after takeoff, at about 10,000 feet, a thud was felt in the aft section followed by severe vibrations. Seconds later the engine flamed out. Adams notified mobile control that he would attempt a landing at the auxiliary field, one with 7200 feet of runway and crash barrier installed.

Almost immediately Lieutenant Adams' T-Bird had complete electrical and aileron boost failure. Total fuel aboard was 580 gallons, but the lieutenant elected to retain the tiptanks since manual jettison seemed inadvisable. Aileron control would be almost impossible if one tank failed to drop.

Lieutenant Adams set up his landing pattern with allowance of extra airspeed to compensate for the additional fuel, a strong wind, the no-flap configuration, and a dead engine. With 180 knots on final he touched down close to the end of the runway and stopped the T-Bird short of the 7000-foot mark, without damage to the aircraft.

Subsequent inspection showed that the Number Three bearing had failed. The shaft coupling then separated from the compressor shaft and the turbine wheel shaft failed just aft of the Number Four bearing. This allowed the turbine wheel to fall free into the exhaust cone as the engine flamed out. Outstanding judgment and skill on the part of this young pilot prevented the loss of a valuable aircraft.

Well Done, Lieutenant Adams.

horror in hell's

This is the story of eight men. It is the story of how some of them lived and how some of them died. It is the story of personal sacrifice, of hardship endured, of death finally met—and for some, survival attained.

Above is an aerial view of Hell's Canyon. It is one of many such canyons which fall away from the 8300 foot plateau which is shown below. Icy streams course these rocky declivities.

canyon

There were eight men on board at takeoff time. There were eight men who almost completed the flight. But half of them are no longer alive. The fact that they died is tragedy in itself. The causes of their deaths is even harder to accept.

Their story properly begins in San Antonio. The day is warm and humid. The crew of the C-119 go about their duties. The pilot and copilot have the clearance to file. The two flight engineers aboard have the last minute inspections to perform and the fuel and oil to check. The three passengers wait somewhat impatiently for the flight to begin. For they are on their way home. Everything is normal, routine. No trouble expected with the aircraft. This is the tenth day away from home and the engines have performed well. And for several more hours everything does go well. The pilot knows that Ogden will have less than perfect weather, but he is equipped by his years of training to deal with weather. Five hundred feet overcast and a-mile-and-a-half visibility is well within his and the plane's capability. But let's let the pilot tell his own story.

"They were having a frontal passage in the San Antonio area. The night before and earlier in the morning several aircraft had reported heavy thunderstorm activity. This was considered but by the time our takeoff was planned, the front had passed so that there was no chance of our getting into any of that. The weather at Hill AFB, Ogden, Utah, was reported as 200 feet and one-half mile. The forecast was, I believe, 300 feet and one mile. This is guessing now, and snow was anticipated. However, the Weather Officer at Brooks didn't feel it would be that bad so he gave me 500 feet and one and a half miles, with no particular emphasis on any heavy weather.

"Right after takeoff the weather was a little turbulent. We went into the clouds before we got to our cruising altitude, in fact before we departed the San Antonio OMNI. Slightly west of San Antonio at cruise altitude, we broke out and the flight was normal from there on. No weather encountered. *(Ed. Note—The pilot obviously means no unexpected weather encountered.)* At the weather briefing, I recall that the Weather Officer had indicated we would hit the clouds just west of Rock River (12,000 feet). That was exactly where we hit it as I recall. After we entered the clouds, flying was smooth in that area. No problems at all.

"There were breaks in the clouds from the Rock River, Wyoming, area to Ft. Bridger. West of Ft. Bridger it began to get a little rough. We put on the carburetor preheat and it was in this area that we discovered the right carburetor heat was not working. The left was working okay. However, the right carburetor heat had been working throughout the ten-day trip whenever it was needed.

"After passing Ft. Bridger, 1553 Mountain Time, I believe, we lost the engine and we tried heat again (approximately 1605M), just in case there was a short in the switch or something. After it was realized that we wouldn't be able to bring the right engine back in, we added power to the left engine and feathered the right. From there on we lost some altitude. During this time throughout the feathering of the engine we probably got down to 11,000 feet. Due to the loss of the engine and rough weather we were unable to maintain altitude with METO power. We went to full RPM and manifold pressure for a few minutes and were able to maintain altitude and safe single engine speed. It appeared at the time we might even be able to climb back to our cruise altitude of 12,000 feet. However, we soon were unable to maintain altitude and airspeed at 11,000 feet, and at this time we bailed out the passengers and two engineers through the back paratrooper doors. (1617M). This was believed to be necessary because according to our ETA we were assumed to be in the Huntsville area or west, which would put us very close to the mountain tops.

"After we bailed them out, we were able to maintain 10,500 feet for a short time but not long. At this time the navigator and the copilot bailed out of the paratrooper doors. *(Ed. note—Four or five minutes later.)*

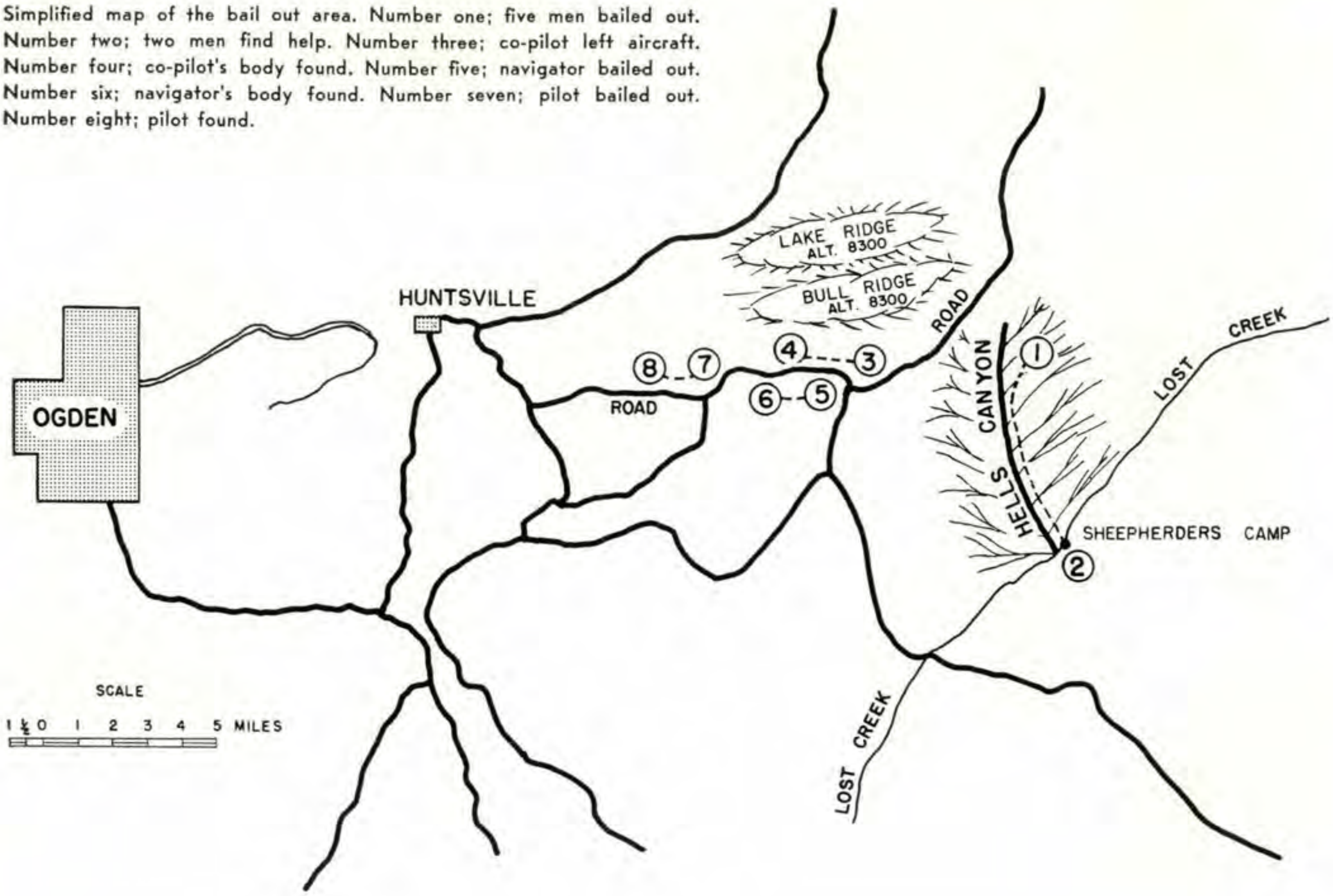
"When the copilot went out, I was tracking outbound from Ft. Bridger. We were unable to pick up Ogden. I was on course and the heading was correct. After the copilot and navigator bailed out I attempted to set up the autopilot. The airspeed had gotten down to 80 knots and the altitude was about 10,200 feet. The first time the autopilot was engaged, the aircraft stalled. I disengaged it, retrimmed the aircraft and re-engaged the autopilot. Soon thereafter I left the aircraft through the rear paratrooper door.

"I figured I was one minute in the air and I landed in the trees. They were short enough so that I was able to reach the ground without hanging up in them. There was snow about a foot deep. I cut the shroud lines on the chute.

"I was in a small gully and I went up one side to see what I could see, but saw nothing in that direction. I headed back, wrapped the chute around me and started walking in the general direction I'd presumed the aircraft had gone. There was about one hour of daylight left.

"Shortly, I came upon what appeared to be a road. I followed this for awhile, looking for a tree area where I could get away from the wind and snow and stay for the night. I went off the road once but the trees offered no protection so I came back to the road and continued on until I found a clump of pine trees. I was approximately two blocks off the road at the time. It was just about dark so I started to make a pallet of pine branches under the tree. I wrapped up in the chute and pulled branches in around me to keep the snow and wind out. I tried to settle down for the night to wait for daylight so as not to

Simplified map of the bail out area. Number one; five men bailed out. Number two; two men find help. Number three; co-pilot left aircraft. Number four; co-pilot's body found. Number five; navigator bailed out. Number six; navigator's body found. Number seven; pilot bailed out. Number eight; pilot found.



walk in circles. About 0030 I heard rifle shots and soon after I was picked up by the jeep patrol."

The pilot was the most fortunate of the lot. He spent about eight hours in the open, clad only in a blue gabardine flying suit, jump boots and light weight gloves. Wrapping in the chute and holing up for the night were the saving decisions in his case.

The copilot was found 60 hours after the bailout, wrapped in his chute but dead from exposure. He was dressed in a summer flying suit and jump boots. No gloves or jacket.

The temperature continued to drop steadily for the next two days. At the time of bailout it was estimated that the outside air temperature was just at freezing. During the first night, a Friday, it was guessed to have gone down to 20°F.

The navigator was not found until ten days after the accident, about three quarters of a mile west of the spot the copilot was discovered. He had tried to start a fire with a dime novel and some twigs he had torn from an aspen tree. The twigs never did burn and even parts of the book remained. He had removed his shoes and socks and placed his feet close to the tiny fire then leaned back against a log and crossed his arms. The parachute was wrapped tightly around him and it is known that he survived at least the first night because of a note he had written. Like the rest of the crew, he was scantily dressed —no hat, coat or gloves. A half-dozen cigarette butts were found nearby.

One of the passengers, an Army corporal paratrooper, survived after a tremendous display of guts and unselfish courage. His story is deceptively modest.

"When the engine conked out, the crew chief came back and told us to put our chutes on. We put them on and he went back up front, and a couple of minutes later he came back and said that we would have to jump. They opened the doors and we went out.

"After we got on the ground we weren't very far apart. *(Ed. note—The five men including the two flight engineers and the three passengers landed within 500 yards of each other and re-grouped easily.)* We met down at the bottom of the canyon and talked the situation over. One of the crew chiefs took charge. We thought it would be best for two of us to start down the canyon (Hell's Canyon) for help, since one of the passengers had a very bad ankle. The sergeant in charge and I started down the canyon for help. The other three built a fire and stayed there the rest of the night. That was about 4:30. We walked until about 7:30. It got dark and the going was very rough. We were having trouble getting through the brush, so we decided it might be best to go back up and join the others at the fire. We didn't know how much

Two close up views of the slopes leading into the bottom of Hell's Canyon. Even on a sunny day at this altitude walking is difficult.

farther it was to civilization. We were on our way back up there when we found a cave. We were tired and cold, so we stayed in the cave the rest of the night.

"The next morning we went back up to where we left them, but they weren't there. We looked for them for about 20 minutes and couldn't find them. There was nothing else to do but start back down the canyon again. We didn't know where they were.

"We walked all day until about 3 o'clock when the sergeant started getting weak. He couldn't go much farther. After a while he couldn't make any progress at all. I helped him as much as I could, but he was getting to be in pretty bad shape.

"The assistant crew chief caught up with us and we talked it over and he said the other two guys also were in pretty bad shape. We knew we had to get help or nobody was going to live. *(Ed. note—At this point the senior crew chief was left behind.)* We walked about two and a half more hours and came to a sheepherder camp and from there we sent help up to the three others. We were taken to a ranch house and from there to the hospital."

The tough little paratrooper who is just under five and a half feet tall, and weighs maybe 130 pounds, actually gave his light army uniform jacket to the senior crew chief who had to be left behind. The two men who walked on left him propped against a tree and made their way on for help. When help did arrive however, it was too late. The senior crew chief was dead.

The three men who were left behind when the corporal and senior crew chief decided to go for help, managed to get a fire started. There they stayed for 17 hours before they too decided to walk out. It will be remembered that two of these were passengers and one the assistant flight engineer. But let's listen to their stories first from the crew chief, a staff sergeant 28 years old. As in the case of all the others he was clothed in very light dress. A light flight jacket, flight coveralls and high laced boots were his clothing for survival in an area as desolate as any in Alaska. Now for the assistant crew chief's story.

"After my parachute had opened and I got my breath back, I could see that there were five open chutes—four besides myself. This was about 1620. I drifted over the other men and landed a short way from them. I could clearly see their parachutes and where they were heading when they landed. I could see one chute hanging in a tree. I hollered and told him to wait until I got there so he wouldn't unfasten his chute and break a leg in the fall.

"After we re-grouped, I told the men that they'd better get their parachutes. The crew chief and the corporal said they were unable to get theirs because they were stuck in the top of a tree. At the time we believed that one of the passengers *(Ed. note—an Army sergeant, first class and a man of about 230 pounds)* had broken his ankle from his descent when he landed in a creek. His foot had gone between two rocks. The other crew chief and the army corporal then decided they would start walking out to try and get medical help. The ranking Air Force non-com passenger agreed that they should do it so they left. We tried to find enough wood to build a fire but it was so wet you couldn't start anything. I then examined the ankle of the Army sergeant and found that it was badly sprained. He could stand on it, and from every indication there were no broken bones at the time.

"We then decided that we had better find a better place to stay and build a fire. We walked about two miles around the side of the mountain and found a large pine tree. We dug underneath the tree, under the snow and found some dry leaves and broke a few dry twigs off the tree. The crippled man tore up his driver's license, all his orders and papers that he had in a notebook, including the notebook to use for kindling. We managed to get a small fire going at first and we slowly got it to going better and better and we had a fairly large fire. We spent 17 hours under that tree by the fire. The next day we decided that if we were going to die, we were going to do it walking. I had asked if I could go alone at 1030 in the morning and make it out of there but the other two voted against that.

"We then decided we would try to make it out—the three of us. So we started back the way we had come up the night before. We found the tracks of the two who had left the night before and we followed them down the canyon. The army sergeant couldn't walk too much because of his ankle, I had set a pace for myself that I figured I could keep up for as long as possible and the other Air Force sergeant managed to stay up with me for approximately four hours. He then seemed to lose all of his energy and had thrown away the part of the parachute that he had around him to keep warm. I gave him my part of it then and he kept slowing down more and more. I tried to make him walk to keep up with me. I hollered at him, cussed him, tried to make him realize that if he did stop he would die. I know that I, if I had stopped, wouldn't have been able to start again, so I just kept going as slowly as possible without completely stopping. The sergeant with me didn't seem to comprehend the fact that he was going as slowly as he was, so he fell slowly behind me. I didn't know whether the first two had made it out. Their trail was quite clear to follow until we got down in to the narrows of the canyon. I would lose the trail most of the time because I was walking right in the middle of the creek. Whenever I would get a chance to walk on the side of the creek in the snow I could see their trail quite clearly.

"I then came upon the other crew chief and the Army corporal, approximately forty minutes from the time I had last seen the ones who fell behind me. The corporal was half carrying, half dragging the sergeant through the snow. I told them to get a move on so we could get out of there. The sergeant didn't know who I was, he was so far into shock. He didn't know what he was doing and he kept falling down all the time. We tried to start another small fire then. The only thing we had was a cigarette lighter and it didn't work. We knew that we would not be able to pack the sergeant out because he weighed close to 200 pounds and our own physical strength was almost gone. So the corporal took off his jacket—the small jacket that he had on—and put it on the sergeant. We set him underneath a spruce tree and left him there.

"The corporal suggested at that time that we try and double time it out of there. I told him we were going to walk an even pace as fast as we could without losing all of our energy and I told him if he fell down that he was going to have to get up by himself because I wasn't going to stop until we got help. He just looked at me and said, 'Sergeant, let's go!'

"We started walking. He stayed about eight feet behind me and not once did he falter in following me. About two hours after we left the sergeant by the tree and twenty-four hours after we bailed out, we came upon the sheepherder camp at the mouth of Hell's Canyon. We pinpointed the canyon we came out of and told the authorities that were there about how far up the others were. They started to search for them."

Hell's Canyon had now yielded two of the five men it had held for over a day. Three were still somewhere in the brush clogged stream bed. Of the three, only one more came out, the passenger with the injured ankle. The two others succumbed to the bitter cold and exhaustion about thirty hours after bail out. The heavyweight with the injured leg kept moving for some time, caught up with the body of one of the others and tried to drag him to the shelter of a tree. Then he himself sat down to die. Twenty minutes later rescuers from the sheepherders cabin found him and brought him in to the cabin. Hell's Canyon had done its worst.

The wonder of the whole story is that any survived. What driving force brought four crewmembers through this ordeal is hard to explain. Those who were fortunate enough to have landed together did not stay together for mutual assistance and protection! A fire was built and abandoned.

No one was prepared, with training and equipment, to face the ordeal that fate had thrust upon them.

Men so poorly equipped for winter survival in the ruggedness of Utah mountains surely have little chance. Light clothing and not a survival kit among them.

The irony of the whole tragedy is that the plane, on autopilot, managed to fly for more than an hour on a northerly heading before it crashed in a pasture in southern Idaho. The cause of the carburetor heat trouble was found to be failure of a small electrical motor. This motor opens a small door to allow engine heat into the carburetor. "For lack of a nail . . ."

Looking at Hell's Canyon from the top of the plateau, the canyons fall away to the stream beds and valleys. It is bleak territory with the snow knee deep, and bare trees and brush furnish the only contrast. The scene is as desolate as any you're likely to see in northern Alaska. And by air, this is only 20 minutes from the warmth and life of Hill Air Force Base. Men fly over this route in everincreasing numbers from East to West and return. The spot where these eight men left the warmth of the faltering plane is directly on a civil airway. Huntsville, a good sized town, was only seventeen miles away from the most distant man to bail out. Yet these men might as well have been in remotest Canada for all the help others could give them immediately. The snow continued to fall and planes could not search. Ground parties in jeeps and snow-gos were practically helpless until the weather cleared. And the rescue efforts by military and civil agencies were quick, thorough and untiring.

A man must plan to be on his own when he leaves his aircraft in this country. He must be equipped to survive for several days until help can reach him. He must be properly clothed and he must have some sort of survival kit. He must obey the simplest rules of survival. If he is lucky enough to be with others, stay with them; he must make a fire and stay with it; he must be prepared to build at least a rudimentary shelter and wait in it for help.

There are thousands of square miles of rough country in these great western states of ours, yet men continue to fly in the comfort of their planes with little or no thought to the emergency that might come. The secure feeling a pilot gets from the knowledge he has two or more engines can be fatal. It must be remembered that the C-119 left from a southern Texas base in summerlike conditions. Five hours later, it was over some of the wildest, fiercest terrain to be imagined. The temperature had dropped over 60 degrees from the time of takeoff to bailout. No one was ready for the sudden transition from complete security to dire peril. Only twenty minutes from home base, tragedy had struck. It could and will happen again. That it happened to these men is their personal tragedy. The ones who survived will never forget. ▲

KEEP CURRENT

NEWS NOTES

Northrop is marketing an exhaust muffler for the Bell Model 47 Helicopters. The new muffler was developed to reduce the noise level of the whirlybird which is used for interplant travel in the Los Angeles metropolitan area. Tests indicate that the outside engine noise was reduced to street noise levels without affecting performance of the engines. The muffler, made of welded stainless steel, is eight inches in diameter and about 34 inches long.

"Talon" has been designated as the official name for the USAF's newest jet trainer, the Northrop T-38. After extensive testing by Northrop and the Air Force, the "Talon" will probably be put into service in late 1960. The new jet is designed for use by units of the Air Training Command in its basic flight training program.

It is a light weight, twin-engine aircraft and expected to be capable, with afterburners, of supersonic speeds at level flight. It was designed specifically to fill the existing gap between primary flight training and high-performance aircraft. This new bird will weigh out at 11,000 pounds and is expected to have a range of 1000 nautical miles. Inside are pressurized tandem cockpits enclosed by jettisonable canopies with individual ejection seats for crewmembers. Further information on performance will be available early in the spring after the initial tests at Edwards. With such a name, how can it escape being called "The Zipper?"

Bell Aircraft's automatic all-weather landing system, originally developed for use aboard aircraft carriers, has landed the Regulus II surface-to-surface guided missile on two occasions as part of an evaluation program. The landings were made at Edwards Air Force Base, California, during October.

The Bell system locked on the missile's autopilot several miles from a selected point of touchdown and guided it to a safe landing. The system, which uses a combination of radio and radar, has also landed a number of different types of aircraft automatically after the pilot has relinquished control.

The Boeing 707 is one type successfully handled, and in mid-December, a B-47 was controlled automatically to a landing at the Lockheed plant near Atlanta, Georgia. The electronic devices fill a specially-built trailer which is parked near the runway.

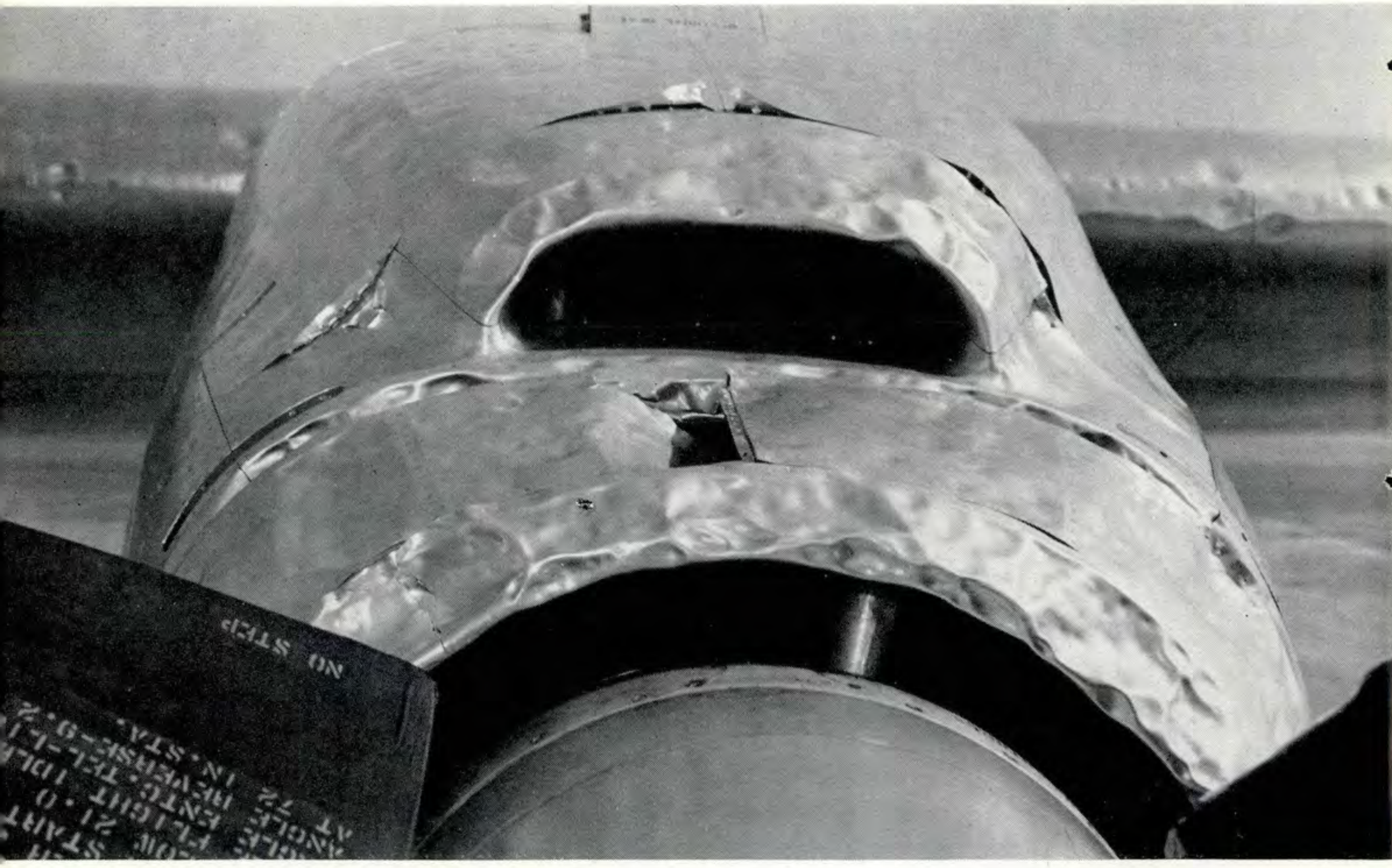
The new and advanced version of the prop-jet Hercules has been successfully test flown and the first version of the C-130B models will be delivered to the Tactical Air Command early this year. The engine power has been increased to 16,200 hp. with four Allison T-56-7 propjet packages and added fuel tanks will give the "B" model a range of 1000 miles greater than the "A" plane which could travel 3000 miles nonstop.

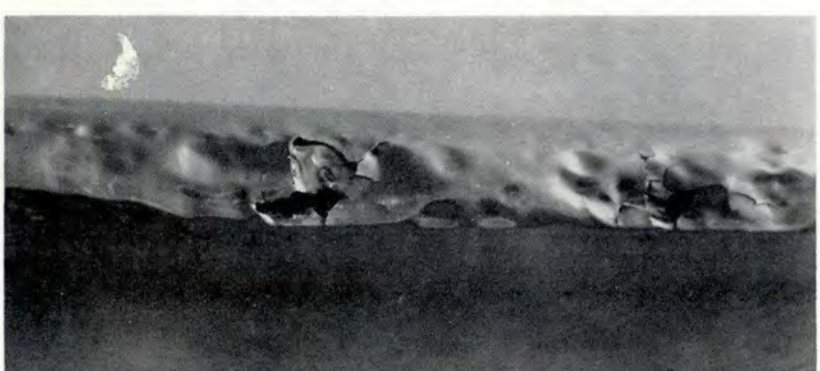
Takeoff weight has been increased by 11,000 pounds (total of 135,000) to provide for additional loading and fuel. It is expected to fly at altitudes higher than 35,000 feet and at speeds of 360 miles per hour. The Royal Australian Air Force is obtaining twelve of the Lockheed C-130s. Five were delivered at the Richmond Station, Australia, in the middle of December.

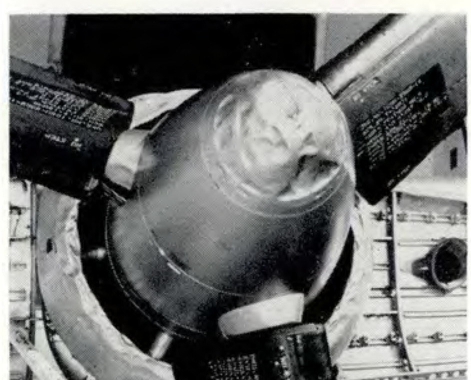
The Air Force has ordered into production the North American Aviation Sabreliner to be designated the T-39. This aircraft is designed to fill the need for a low cost, high performance jet utility transport and trainer for all the military services. The prototype airplane is powered by two General Electric J-85 turbojet engines. It is 43 feet long, has a swept-wing span of 42 feet and is smaller than most operational jet fighters.

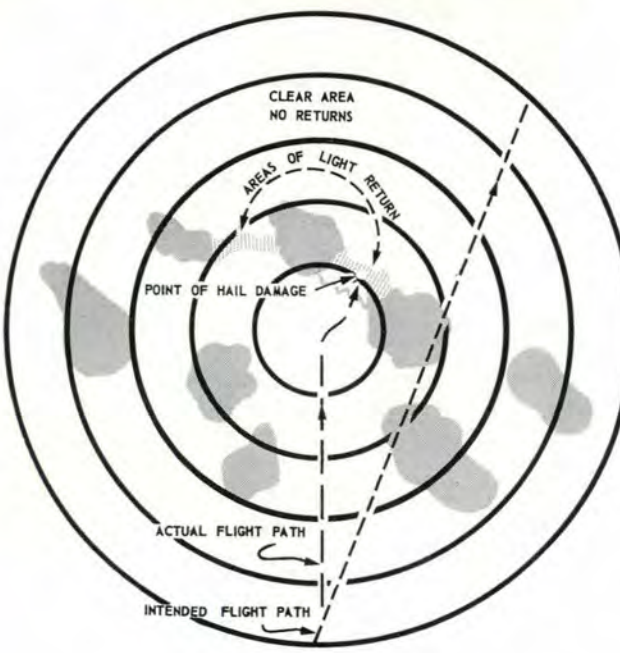
Production of the F-100 Super Sabre is scheduled to end this year. ▲

WHEN THE SKY THREW ROCKS









If there are any more non-believers who scoff at the destructive force of hailstones, these pictures should suffice to convert them. The C-133A shown here was subjected to the fury of baseball size hailstones for just thirty seconds. Preliminary sheet metal repair estimates run to 11,500 manhours. Overall repairs are expected to take up to 14,000 manhours.

The C-133A was cruising at 18,000 feet in the vicinity of Wink, Texas. The APN-59 radar set was in operation and was giving "nice clear returns," according to the pilot. The radar set was being used to pick the best route through a line of cumulus type clouds whose tops were estimated to be 23,000 feet. As can be seen from the sketch of the APN-59 picture the areas of light return are clearly defined between the main cells of the numerous storms in the area.

A deviation of 15 degrees left of course was being flown to pass between two of the cells and it was estimated that four or five minutes would bring the C-133A into a clear region where the proper course could be maintained to El Paso. The clouds between the cells were layers of stratus and at first were of the dry type with the outside temperature at 10 to 12 degrees below zero Fahrenheit. The aircraft was cruising at 260 knots true airspeed. According to the scope there were four to five miles between the two areas of heavy return, and the C-133A was in the clear between layers of stratus, when the crew was startled by a rhythmic loud ticking noise. This lasted about four seconds when there was a terrific roar and explosion, and the copilot's center window was penetrated by the hail. At no time was more than relatively light turbulence encountered. The hail was not picked up on the scope prior to the incident because it just wasn't there. The falling of the hail and the arrival of the C-133A at that precise point in space were apparently simultaneous—a coincidence as unexpected as it was unfortunate. What's the answer? Top all cumulus type clouds if possible. In this case, according to the pilot, the freight load on board would allow no higher flight altitude than 20,000 feet at the time of the incident.

The pilot in the left seat dropped his seat so that his head was below the glare shield. The aircraft commander in the right seat had a baseball type cap which he pulled down over his forehead so that his eyes were shielded against the flying glass from the broken windshield. Most of the glass and hail which came in flew between the pilots, passed the engineer and hit the wall in the rear of the cockpit compartment.

During the entire incident the engines ran smoothly and although the oil coolers were severely damaged, the engine temperatures remained normal. Using a higher flare speed than normal, because of the severe damage to the leading edges of the wing surfaces, the plane was landed at El Paso without further damage. ▲

Sitting in the cockpit of a modern airplane, you are one of the fastest men alive. But, did you ever stop to think that after all, you may be . . .

THE SLOW SPEED DEMON

Anchard F. Zeller, Ph.D.,
Aero Medical Safety Division,
Flight Safety Research.

It is a matter of speed. "Speed Kills," the experts say. Speed causes accidents. Speed does lots of things that perhaps shouldn't be done that way. But did you ever stop to figure out just HOW speed kills and causes accidents?

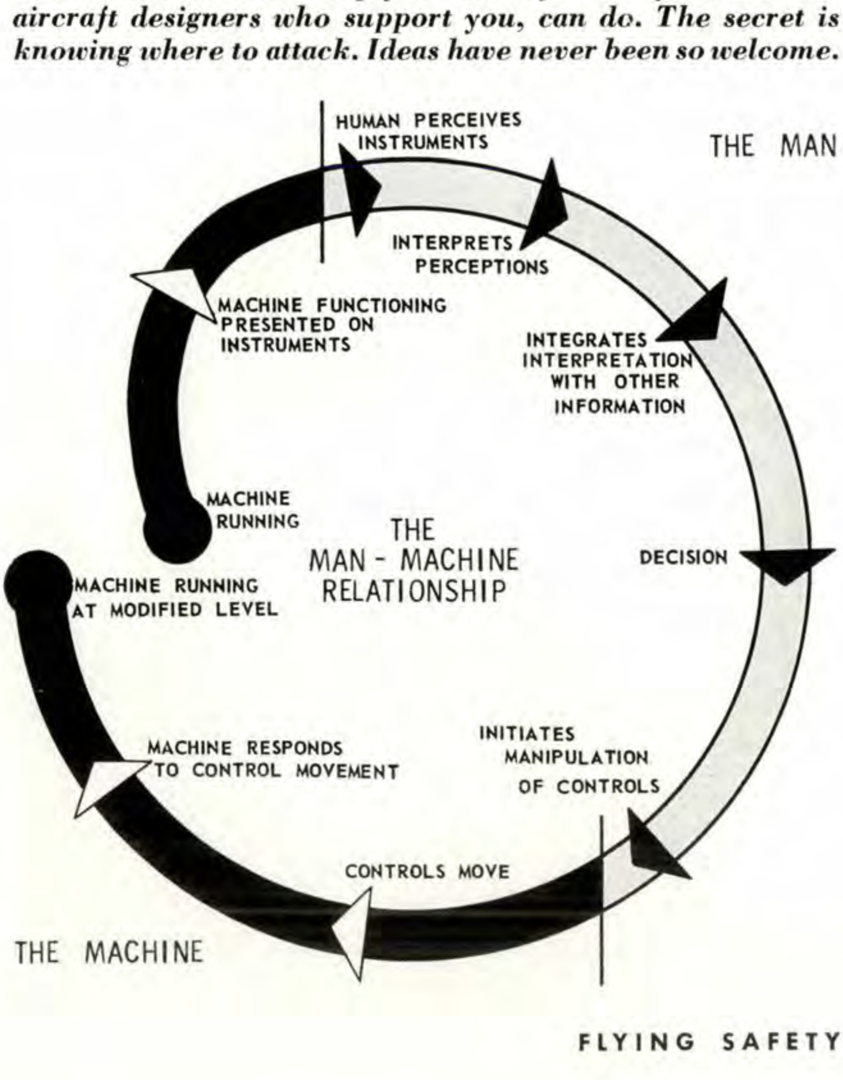
Chances are it works in a way directly opposite from the way you've been accustomed to thinking about it. Because there is good evidence to show that the lack of speed is the real villain in the case. Even more villainous because it shows up where least expected.

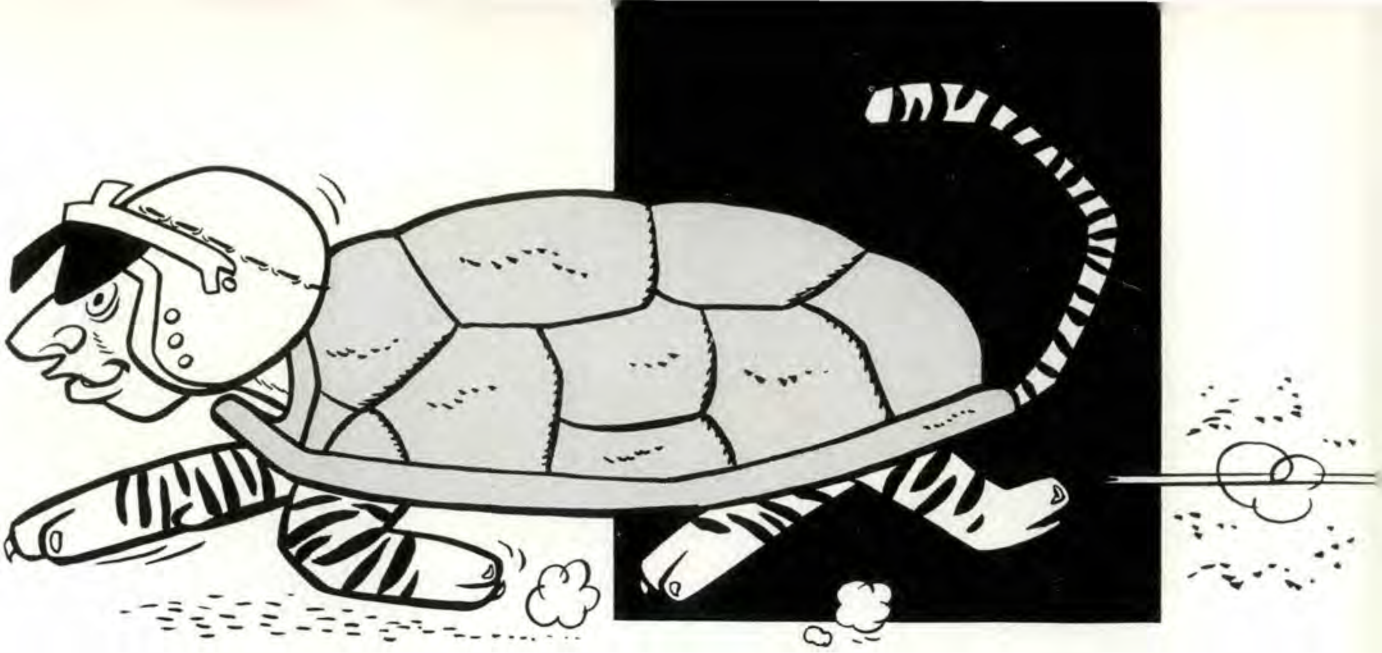
There are a few ways for a pilot to combat the villain in forthright battle. Gritted teeth and tense muscles won't make much of an impression. At least for now, the real answer lies in outwitting your enemy. This you, and the aircraft designers who support you, can do. The secret is knowing where to attack. Ideas have never been so welcome.

Although the Air Force, with the assistance of industry, has established an enviable safety record over the past several years, the cost in lives, equipment and decreased national defense potential is such that the loss still represents an unacceptable drain. In developing measures directed toward reducing these losses through the prevention of accidents, the first step is an analysis of the cause factors which have contributed to past accidents. When these cause factors are considered, one which consistently appears year after year is human error.

Approximately one-half of all accidents have, as a cause "error on the part of the pilot." Other human agents such as maintenance support and supervisory personnel are also involved. In addition, almost one out of six of the accidents experienced have the primary cause assessed as "undetermined." If it is assumed that half of these are attributable to the human, this means that collectively almost two-thirds of all major USAF aircraft accidents have a human cause factor.

In examining these human errors, the one thing which is most readily apparent is that the errors do not necessarily represent either negligence or willful violation on the part of the pilot or other personnel concerned. They are rather a reflection of the fact that the human was placed in a situation in which he was not able to respond adequately to the demands of that situation. An inescapable conclusion which follows is that if the accidents in the human error category are to be reduced, it is necessary to consider the human in





terms of his inherent design limitations. Thus, the limits of the demands which can be made on the human system can be considered in the design of the equipment which he must operate.

In order to consider the pertinent human design limitations, the role of the human in the man-machine relationship must be defined. In its simplest form this man-machine relationship may be thought of as a closed circuit.

The functioning of an operating machine is symbolically presented in the form of an instrument. This instrument, if it is to perform its function adequately, must accurately reflect the basic operation of which it is a presentation. And it must be so designed that changes in the basic operation are rapidly and effectively indicated in the instrument.

In the second step, the instrument is perceived by the human through a receptor system. In order for this perception to take place, the instrument must be designed so that the presentation is well within the sensory limitations of the human receptor system.

Further, it must be presented so that a minimum of time is required for an accurate interpretation of the presentation perceived.

In the third step, the perceived and interpreted instrument presentation is used as a basis for initiating a response. For the sake of efficiency, this response should be simple and easily learned.

The human response then is the means by which some mechanical control system is activated. This control should be directly associated with the basic operation of the machine in question so that manipulations of the control are directly reflected in the activity of the machine. This, again, is directly and accurately presented in a modification of the instrument reading. This, then serves to inform the human operator as to whether or not additional control changes are necessary.

In practice, this simple system is complicated by the fact that in a complex piece of equipment (such as a high - speed, high - performance aircraft), many functions of the basic mechanism are acting as an integrated unit and are necessarily presented by means of a complex instrument system. The human operator, in addition to interpreting the information presented by the instruments themselves, must also integrate information perceived outside the cockpit. At times, for instance during a letdown, he must integrate both of these with instructions obtained by reading a relatively complicated chart. If the demands of the situation exceed the limitations of the pilot in the brief time allowed, the result will quite possibly be an inadequate integration of the information received. This results in a faulty decision, which, in turn, leads to the wrong response. In this complicated setting, the response is all too often not a simple manipulation of a single control which directly results in the desired modification of the basic functioning. Instead, it is rather a complicated multiplicity of actions which must be integrated in order to affect the total operation of the mechanism in the desired manner. This requires the manipulation of numerous types of controls, dials, knobs and levers, each of which affects its own small portion of the total operation.

The total result of this is a modification of the integrated functioning of the entire mechanism which is again reflected in the basic instrumentation. This presentation must then be re-interpreted. This continuous perception and integration of continuing information from a variety of sources must be carried out by the pilot, in addition to other required activities.

Although not as readily apparent as in the machine, there are in the human, limitations which cannot be safely exceeded. Any attempt to design a mechanism which the human must operate and/or maintain which exceeds these human limitations can result in nothing better than ineffective operation of the equipment and, all too often, destruction of both the equipment and the operator. Whether or not the physical-sensory, physiological or psychological aspects of the human are considered, these limitations are important.

As a physical-sensory structure, the human operates according to the laws of mechanics. He is a system of weights, counterweights, balances and levers. Some of the limitations of the human, considered as such a system, are obvious. For example, he can only reach so far and lift so much. There are other limitations, however, which are much less obvious but which are very important, especially in terms of the ability to operate high-speed, high-performance aircraft.

For example, the mechanical transmission of a light stimulus from the eye to the brain and the integrated response which results from the in-

terpretation of such a transmission is a time-consuming process which can vitally affect the successful operation of an aircraft.

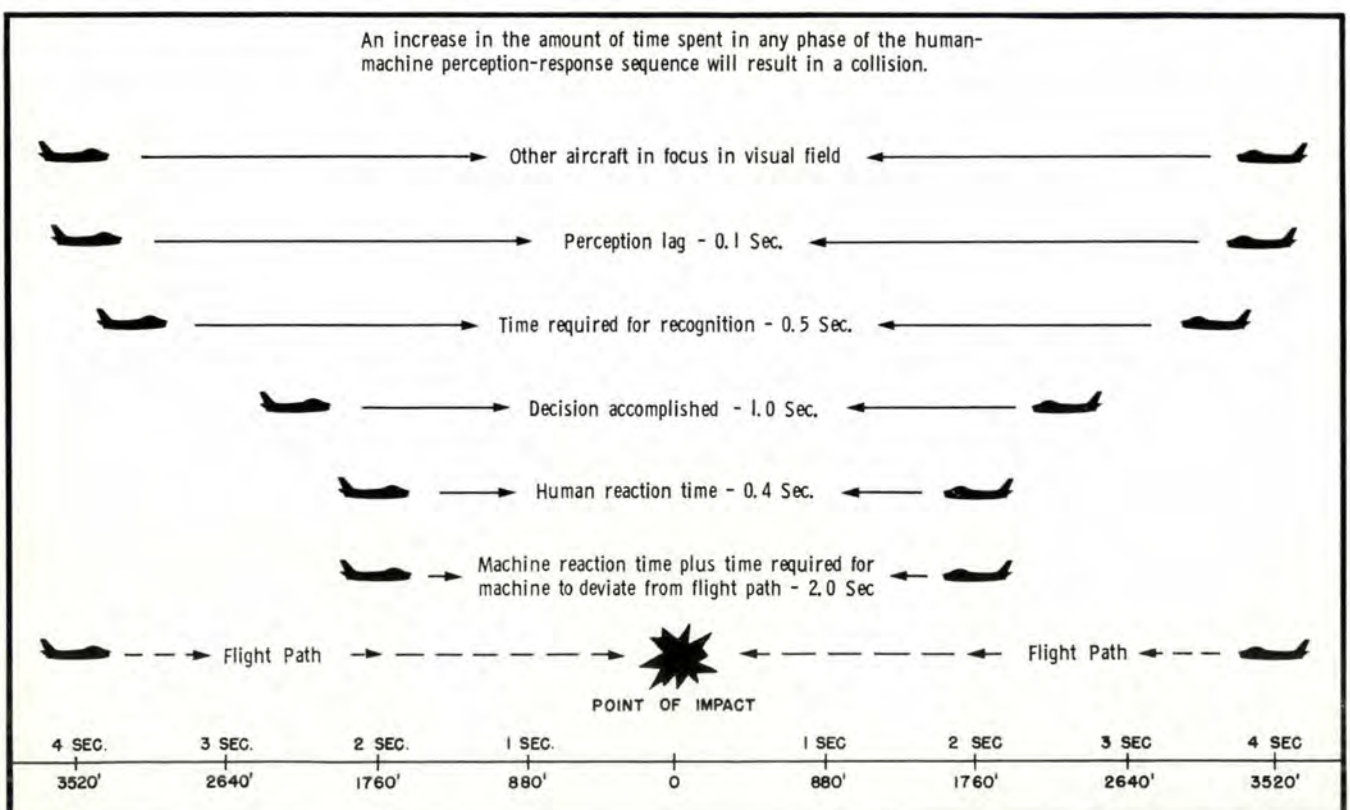
When a light stimulus strikes the eye, and from there is transmitted to the brain in the form of a nerve impulse, a measurable lapse of time occurs. This lapse of time is only on the order of from 30 milliseconds to three-tenths of a second, but when considered in terms of time and distance, it becomes important.

An object traveling through space at 60 mph is traveling at 88 feet per second, or 8.8 feet per one-tenth of a second. If a perceptual lag, i.e., the time required for the transmission of a nerve impulse from the eye to the brain, of one-tenth of a second is considered, this means that an object passing across the visual field at 60 mph is perceived 8.8 feet behind where it is actually, physically located in space

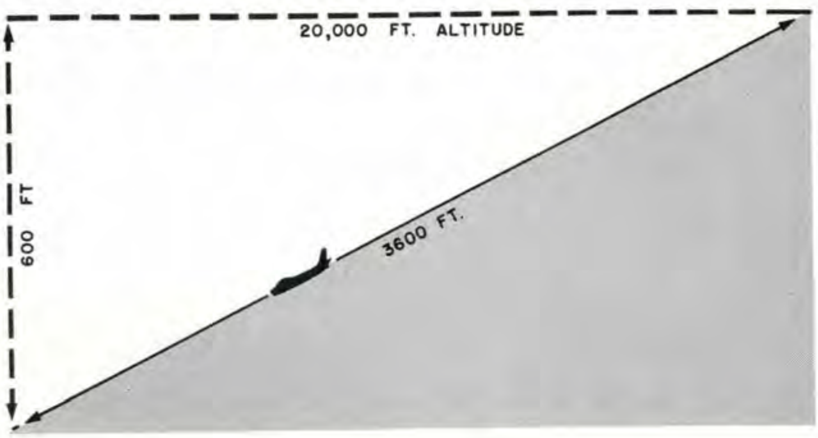
In ordinary living this time lag is not usually important although in the case of automobile drivers in a head-on collision course, such a perceptual lag can lead to a miscalculation of distance which could and undoubtedly has contributed to accidents. Another example of the importance of perceptual lag is found in the frustrated duck hunter who fails to take this time into account in determining the proper lead required for a successful shot.

Multiply this by ten. When speeds of 600 mph rather than 60 mph are considered, such a time lag becomes of critical importance. Now, during

Estimated Human-Machine Time-Distance Relationships of two aircraft on 180 degree collision course, flying at 600 miles per hour.



Even under ideal conditions, seven seconds are required to read the standard altimeter. During this time a jet might move 3600 feet along its flight path, and 600 feet downward.



that same one-tenth of a second, an object has traveled 88 feet in space. This means that the perception of that object, assuming a one-tenth second perceptual lag, is in error by that measurable amount. The perceptual lag is, however, only the first of many time lags involved in a perception-response sequence. When the nerve impulse is first transmitted to the brain, the individual only knows that something is in the visual field. Recognition requires still further time, possibly as much as a half-second or more.

Once recognition has been accomplished, the information must be evaluated and interpreted and a decision reached as to the action to be taken. This decision time may be on the order or a second, or in many cases, may involve seconds.

Following the decision, the response is then initiated. This also requires a minimum time on the order of several tenths of a second. In the operation of an aircraft, the human perception-response time is only the beginning of the total man-machine-response sequence.

Two other factors have to be taken into consideration:

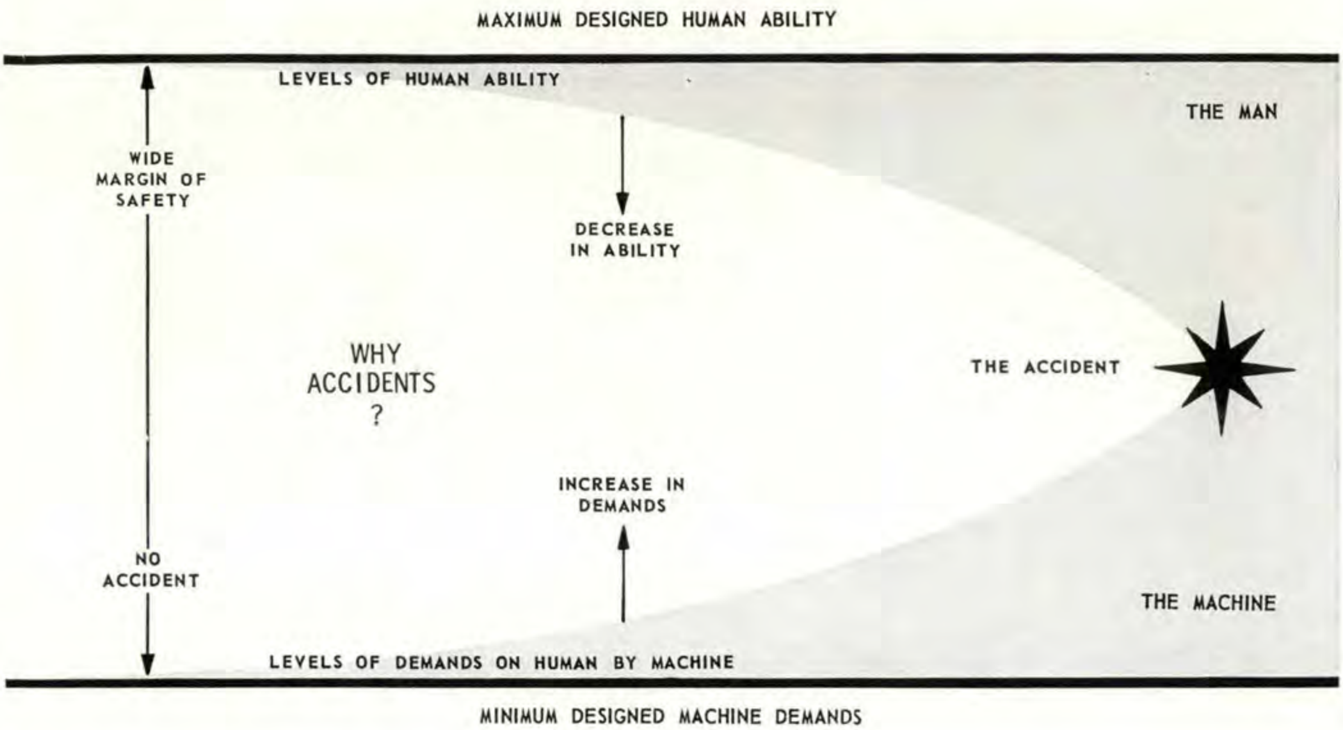
• The time lag in the response of the machine to the controls, and

• The time required for the aircraft to deviate from a given flight path once the controls have been actuated.

For example, if an aircraft could accelerate at the rate of 1G per one-tenth of a second for five-tenths of a second (at which time acceleration of 5G would have been reached), the aircraft would have deviated less than 10 feet from its given flight path at the end of this time. Summarizing this information, if two aircraft were on a collision course at 600 mph, four seconds before the point of collision, these aircraft would be one and one-third miles apart. If all of the steps in the human-machine-perception-response sequence were executed precisely, a collision could be avoided. If excessive time were taken in any one of these steps, a collision would be inevitable. In view of the fact that it can be readily assumed that the speeds of new aircraft will increase while the response times in the human will remain unchanged, the necessity for recognizing the importance of these human limitations becomes apparent.

There are other limitations of the visual system which are of importance to the pilot. For example, the individual looks into the cockpit, looks outside the aircraft and then refocuses his sight on the instrument panel. Such action takes approximately two seconds. Scanning of the instrument panel is also time-consuming. As an example, a lateral movement of the eye of 20 degrees will take approximately five-hundredths of a second to accomplish.

A practical example of the time consumed in a visual process is the time required for the reading and interpretation of a standard flight instrument, the altimeter. Evidence developed almost ten years ago indicates that it takes approximately seven seconds for each reading under ideal laboratory conditions. Even under these conditions, almost one-sixth of the readings are in error, one-tenth of them being in error by as much as 1000 feet. During the seven seconds required for a reading of this instrument, a pilot in a standard jet penetration from 20,000 feet at 350 mph at a rate of descent of 5200 feet per minute would have traveled 3600 feet along his flight path and descended 600 feet vertically during this seemingly short period of time.



Still another visual factor which has received considerable attention is the fact that during periods of low illumination, there is a modification in the visual receptor system with the result that a different group of receptors are involved. These dim illumination receptors (rods) have different characteristics which must be taken into consideration in the design of instruments and particularly in the design of cockpit lighting. The results of experiments on twilight vision are well known and the red-white cockpit lighting which has been developed from a recognition of these limitations is now recognized as an essential for adequate night operation of an aircraft, and should be made a mandatory part of all future cockpit illumination systems.

Other sensory systems which are important are the auditory system, the kinesthetic and the tactual systems. It should be remembered that the pilot must not only integrate visual perceptions into a meaningful response, but must also integrate these perceptions with information received through the medium of other senses. The further exploitation of these other senses would appear to be a fruitful area for future consideration.

A demonstration of the importance of considering kinesthetic and proprioceptive simuli (deep body sensations) as these relate to aircraft accidents is found in the confusion which can arise when the information presented to the pilot through the medium of the various senses seems to be incompatible.

The resultant disorientation, commonly referred to as vertigo by pilots, has been responsible for a large number of accidents. One specific design factor which has been found to be important in creating this condition is the location of the radio and navigational equipment which is such that the pilot must turn his head and look into the cockpit after having changed hands on the stick in order to make appropriate settings. Once attention is re-focused on the instruments, discrepancies between the pilot's feeling of where he is in space and the indications which his instruments give to him, are conducive to confusion and faulty decisions and control movements. These often lead to accidents.

Although the radio and navigation equipment have been the prime offenders isolated for attention, consideration of design should be such that diversion of attention, particularly during critical phases of flight is minimized. Aircraft attitude changes which have gone unnoticed by the pilot, as well as rapid head movements which stimulate the semicircular canals, tend to give the pilot false sensations regarding his position in space.

The discussion to this point presents a relatively gloomy picture, however, once human limitations are recognized there are a number of practical remedial measures which can be applied to minimize their effect. These include design of equipment, training of personnel, methods in which the equipment is used, and meaningful supervision. A consideration of these remedial measures, as well as a discussion of other important limitations will be contained in the next issue. ▲

No Problem Approach

Captain Harold J. Eberle, Flight Safety Research Liaison Officer, Edwards AFB, Calif.

A Flying Safety Officer spends five minutes and about one dollar thereby saving two pilots and a T-bird!

The trusty T-Bird was just leaving the runway on a routine takeoff. On the climb the control tower operator contacted the pilot with this reassuring message:

"Five, six, seven, this is the control tower. You've lost a wheel. We're standing by to assist in any way we can."

The big question is: What would you do if *you* were the pilot? What would you do if you were the Flying Safety Officer? Here are the facts, man. Here is what really happened, when it really happened.

The nosewheel left the airplane just after it left the ground. The pilots didn't know it, but the driver of a fire truck stationed beside the runway saw the wheel rolling along the runway and reported it over the crash radio. The tower informed the pilots who made a low pass over the mobile control with the "gear" extended. When told that their nosewheel axle was bare but in normal position, they remained calm and asked the ground troops to research the subject for the best method of landing the bird. While the research was going on, the pilots went to a nearby base to practice GCAs while they used up the fuel, with the knowledge that the deck would be cleared for action upon their return. Real cool fellows.

Meanwhile, back at the ranch, the operations people began the staff study necessary to make the decision of where and how to get this bird down. The primary goal was to save the crew, of course, but if the airplane could be saved from damage, this, too, would be nice. The handbook gave procedures to follow if a wheel wouldn't come down, but nothing was said about a bare axle. The rumor started that the axle would break off and possibly damage the plane and crew. Therefore, initial plans were made to instruct the pilots to belly in the airplane on an adjacent dry lake, and the crash equipment and fire trucks were so dispatched. The plot was developing nicely for our heroes upon their return and an accident was about to happen.

The plot, however, was not over. As the trusty fire trucks disappeared over the horizon, our intrepid Flying Safety Officer appeared on the scene. He had learned at the FSO School that if he did not know the answers, he should consult with someone who does. In a moment of inspiration, he decided to call a friend whom he knew had been reviewing T-Bird accident reports for several years. Who knows, this same thing may have happened before and an answer may be available. A long distance call to him brought the "No Problem" approach to the whole thing, and the suggestion to land the airplane with the naked strut in foamite on the runway. He suggested that the pilot be advised to land normally and drive the airplane up to the foam on the main wheels with power if needed and then gently place the axle down in the foam.

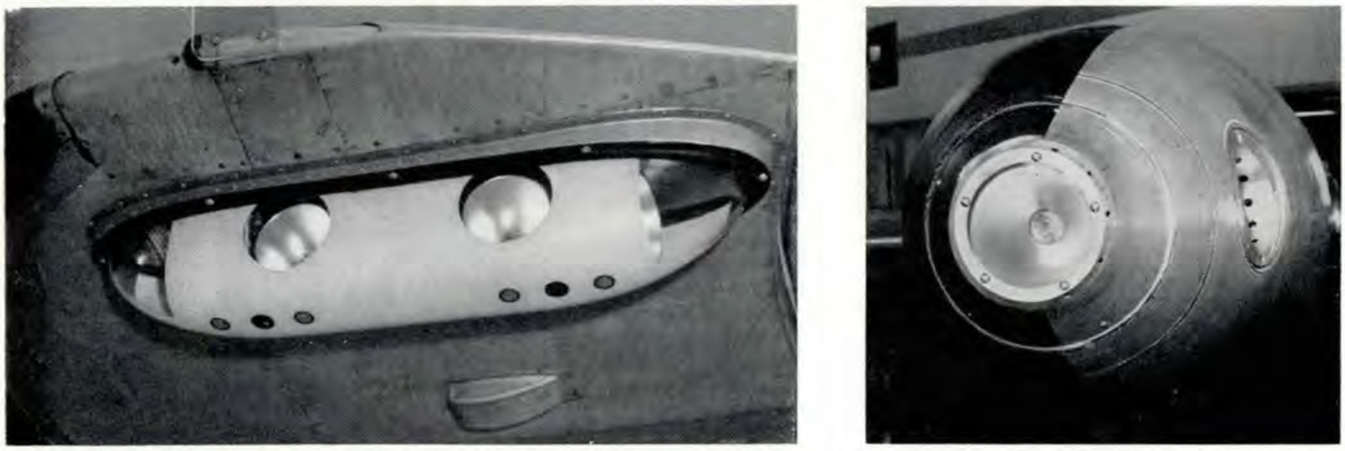
So while our cool, calm and collected pilots were practicing their GCAs, the stage was set. All this was subject to their concurrence, of course. The runway was foamed from the 5000-foot mark until all of the excess foam available was used up. This foam was not placed down until the plane was back in the local area and ready to land so it would still be fresh when the plane touched down. The pilot in the front seat made a normal landing on the first part of the runway and drove up to the foam where he placed the strut down as planned and cut the engine. He had no difficulty keeping the nose in the foam with brakes. The pilot in the rear (as per prearranged plans) was very busy during this landing roll raising flaps, turning off the battery, generator, ignition and fuel shutoff switches and anything else that he could find to turn off. Their seat pins had been placed in prior to touchdown. These pilots exercised good judgment and planning in that they decided prior to the landing who was to do what, when.

The only damage done was the wearing away of the axle, which was not considered an accident.

It isn't very often that the Flying Safety Officer has this much advance notice of an accident about to happen. It should be remembered though, in this whole accident-prevention business that these occurrences which may seem to be freaks or local incidents may in fact have happened elsewhere in the Air Force. We can only prevent accidents if we spread the word and if we use everything at our disposal to fight the battle. This is an example of one of the odd-ball situations that could have been an accident.

Who is to say what other situation may arise at your base and what sort of solution may be necessary? This is a "heads-up" business and alertness is the word! ▲

FRANTIC FIREFLY



The Atkins Light on the C-54 and T-33 for test purposes. The final version will have only one light to the side.

Ask any professional pilot to name the three things about his profession that concern him most.

If one of those three is not "The Mid-Air Collision Problem," you may have reason to wonder about his professional status. With all the action that has come about in recent months in the serious attempt to eliminate this Medusa, there still remain many heads to chop. One of the most prominent of these is the matter of being able to see the other guy.

It has been pretty generally conceded that the business of seeing another unpainted, unlit, unmarked-in-someway airplane in the various shades of sky, just will not work. With recent improvements along these lines, some pilots have been heard to express wonderment at seeing so many more airplanes up there nowadays. The number has not actually increased a great deal in the past several months, but while it may border on "the frightening," it is encouraging to see things being done about making aircraft a little more easy to see. Somebody is thinking.

We are simply re-proving the adage that "Necessity is the Mother of Invention." It would probably be difficult for a professional pilot to think of a "Necessity" more deserving of inventive effort than that of collision avoidance. It is not particularly surprising therefore that a pilot has come up with at least a partial solution to the problem. Captain H. William ("Ab") Atkins is a pilot for Northwest Orient Airlines. On this job and others he has piled up a total of more than 13,000 flying hours. In classic understatement he remarked, "I have been exposed to numerous potential collisions, and I became concerned with the inadequacy and vulnerability of my position." You who have been charged with the responsibility of maneuvering a plane from one point to another on the crowded airways of today, know just what he means.

Four years ago, "Ab" Atkins decided to try for a solution to the collision problem. In the course of his search he interested the engineers of the Minneapolis-Honeywell Company and the result of their joint labors is the "MH-Atkins Collision Avoidance Light."

The light incorporates two main features. It is a directional light that indicates "relative-danger" and it employs a blue white condenser discharge lamp. The directional feature is accomplished by flashing three different lamps, each at a different rate and into a different zone. The forward zone is 90 degrees wide and the light flashes at 160 flashes per minute, or approximately three flashes per second.

The side lights also cover a 90-degree zone and these lamps flash at 80 flashes per minute. The tail zone covers

The Atkins Light is now in use and under evaluation. It is trying to tell you something that may save your life. Don't turn it in as a flying saucer. Take a second look and report.

another 90 degrees and this lamp flashes at 40 flashes per minute. Figure 1. The theory behind the light system is that the flashing rate in each zone will indicate the closing rate, and the pilot's reaction to each flashing rate is a natural one for the collision danger.

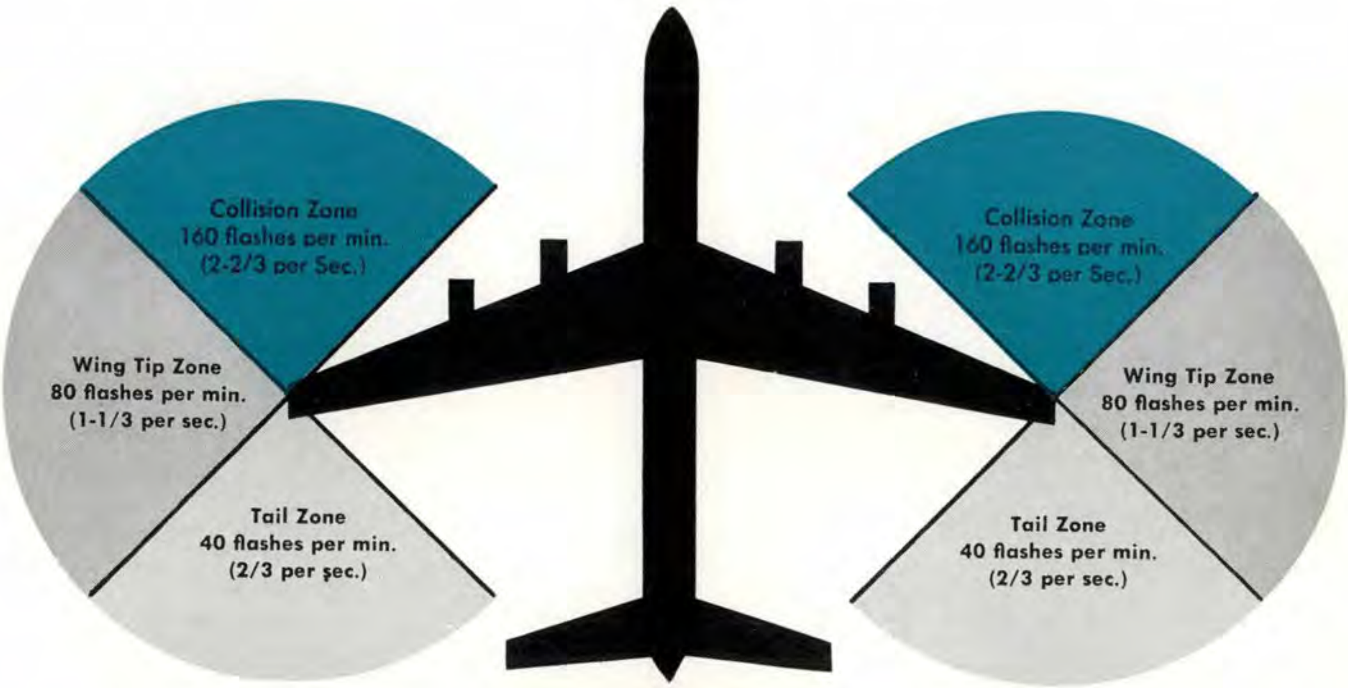
The two wingtip installations are, of course, synchronized through one sequence switch and flash simultaneously from each position. The condenser discharge lamps are on for a very short duration (one-thousandth of a second) and the color is a very blue white. The short duration does not affect a pilot's vision by leaving an after image, nor does it spoil his night adaptation. It is definitely distinctive in its nature from any light normally seen.

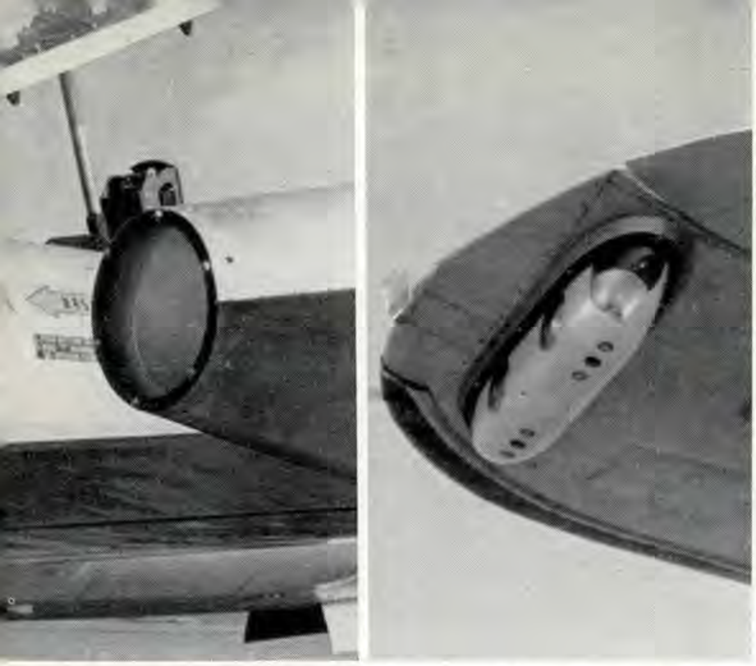
The blue white was chosen over red and other colors for several reasons. White light is more intense. It allows a peripheral vision of 208 degrees as against 30 degrees for a red light. Fog and haze penetration is better on a ful spectrum light and, as said before, it is distinctively different from other ground and air lights. The object here is simply to provide a distinctive, eye-catching light that will tell the pilot immediately that there is a target, that it is definitely an aircraft, to show its relative direction and to indicate the relative danger that exists because of it.

The Air Training Command has made a preliminary evaluation of the Atkins Light. In this test, the light, in a developmental or "bread board" configuration, was mounted on a T-33 baggage rack. The evaluation was conducted at fifteen ATC bases and at seven other bases and civil airfields. The light was observed and reported on by 65 other aircraft and at least 250 observers on the ground. The T-33 with the light was flown in the traffic pattern with as many as 17 other planes at one time to determine if there would be any distracting effect on other pilots. None of the pilots in this particular test reported any distracting effects. Detection and identification by air-to-air observers at distances of 30 miles were common throughout the test. On two occasions, ground observers reported detecting the light and determining the direction of travel at 50 miles.

Just to make sure, the light was turned off several times for a sufficient time for observers to lose the location of the test aircraft. Then it was turned on again and the time for air-to-air detection from an unknown position was recorded. The average time to detect the aircraft in an unknown quadrant and determine its direction of travel was 15 seconds. On a very dark night, an observer aircraft flew tight formation in a wing position for approximately one hour. The observer pilot reported no vertigo effects nor loss of night vision, however the light was annoying. In-trail formation was tried several times with no serious objections. This objectionable feature has since been overcome by a modified switching arrange-

Figure One





Two more views of the MH-Atkins Light installed for evaluation tests.

ment which permits turning off the light on the wingman's side. The two aircraft together provide the single set of lights.

The light was intentionally flown in instrument conditions at night on two occasions by pilots of the Training Command. There was no noticeable vertigo effect. It did produce a peculiar halo-like appearance around the aircraft. Observers reported seeing the light through the clouds for about three miles. In the daylight, the light assisted in detecting the aircraft for a distance of about two miles. During daylight, in restricted visibility conditions, such as haze, fog and smoke, the light raised the detection distance over that of the unlighted aircraft. In these tests, visual contact with the aircraft was lost at four miles, but the light was visible at eleven miles.

The ATC evaluation was also flown in unrestricted visibility conditions on many occasions. In the original test configuration used, the light did not attract attention in the peripheral vision as well as was hoped. It was, however, of great assistance in detecting the aircraft when scanning the area. Several Mobile Control and Tower officers reported that the light was helpful in locating an aircraft in the vicinity of the airfield. It was particularly useful in spotting an aircraft reported on initial approach. The time saved in locating aircraft is of considerable importance to the mobile controller in his job of providing proper traffic pattern spacing. When viewing the aircraft down sun, the light was of some assistance, but when looking toward the sun, the light could not be seen beyond two miles. The aircraft itself, of course, was visible before this distance.

It must be remembered that the ATC test was made with the fuselage installation. The results with this type were most heartening. But it was realized that any anti-collision light, to be fully effective, must give airplane-wing-attitude throughout the fore and aft quadrants in order that the observing pilot has more than a single point source of intelligence to deal with. This has been done with the fore and aft facing lamps located at or near the wingtips. It is obvious that a single point of light, such as a single wingtip light, gives no information about wing attitude. However, when two lights flash simultaneously on both wingtips, with sufficient horizontal light beam overlap (45 degrees in this case), we have a source of intelligence throughout the entire 90-degree fore and aft quadrants of an aircraft.

Here, again, because of the fact that there are two light sources, we have information available which is analogous to the automobile headlight situation. If you meet a car at night on the highway with only one headlight, you give him a lot of room. But as soon as you see two headlights, you begin to get "ranging" or "rate-of-change-of-range" information, and immediately you can evaluate the situation more clearly and plan your tactics accordingly. With the use of the wingtip high intensity lights, this information is made available to you long before you can see the outline of the airplane itself.

With respect to conspicuity, the inventor claims the following night-time ranges:

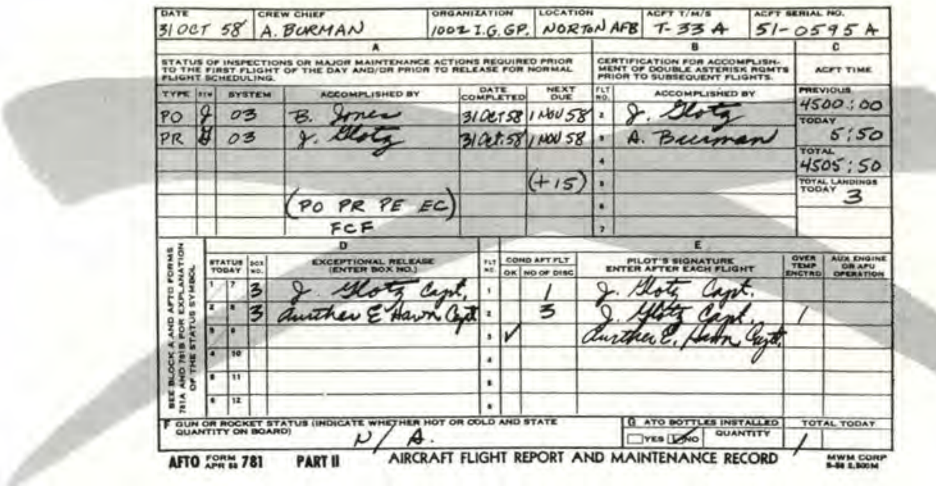
1-15 miles, the light is very intense.
15-25 miles, the light is very good.
25-35 miles, the light is good.
35-50 miles, the light is distinguishable.

The above ranges are for an average clear night. Some pilots have expressed concern that they might be able to see too many aircraft at once with these ranges. In answer, the inventor says, "I do not feel that this is a problem, since actually no range is too great provided the pilot is also given adequate intelligence. Experience has shown that at distances beyond where you need to be concerned about another aircraft, the two fore or two aft lights appear as one, hence, you may ignore these intruders until two lights are visible."

It has been generally agreed that there should be no replacement or removal of existing standard aircraft light systems. The condenser-discharge light would supplement these systems. There is a need to keep the red and green wingtip lights in the "steady-on" position with the new-type light installed. The red and green wingtip lights are useful in the situation where the 80-flash per minute rate is observed, since they will quickly tell which side of an opposing aircraft is in view. The red and green lights, when left in the "steady-on" position, appear to the eye much sooner and also appear much brighter when used with this system.

The lights are now in use and under evaluation by various commercial and military agencies. They are installed in pods at the wingtips on the larger aircraft and in the case of the ATC T-Bird, have been flush mounted in the tiptanks. These "bread Board" models have been fabricated to provide an easy installation for proving the value of this light concept. They should not be considered as representative of the ultimate size, shape and weight.

But, the MH-Atkins Light is flying. Some of you may have seen it during your trips around the country. If you haven't, and suddenly come across something that looks like a frantic firefly going off in all directions, take a second look. If it matches our description, it's trying to tell you something—that may save your life. Don't turn it in as a "flying saucer" (as some have done), but take the time, if you will, to give us a report. Tell us what you think of its effectiveness. Your information may help in the evaluation and could conceivably oil the wheels of progress toward your safety from mid-air collisions. ▲


DATE: 31 OCT 58 | CREW CHIEF: A. BURMAN | ORGANIZATION: 1002 I.G. GP. | LOCATION: NORTON AFB | ACFT T/M/S: T-33 A | ACFT SERIAL NO. 51-0595 A

A — STATUS OF INSPECTIONS OR MAJOR MAINTENANCE ACTIONS REQUIRED PRIOR TO THE FIRST FLIGHT OF THE DAY AND/OR PRIOR TO RELEASE FOR NORMAL FLIGHT SCHEDULING.

B — CERTIFICATION FOR ACCOMPLISHMENT OF DOUBLE ASTERISK RQMTS PRIOR TO SUBSEQUENT FLIGHTS.

C — ACFT TIME

TYPE	SYM	SYSTEM	ACCOMPLISHED BY	DATE COMPLETED	NEXT DUE	FLT NO.	ACCOMPLISHED BY
PO	/	03	B. Jones	31 Oct 58	1 Nov 58	2	J. Glotz
PR	/	03	J. Glotz	31 Oct. 58	1 Nov 58	3	A. Burman
						4	
					(+15)	5	
			(PO PR PE EC)			6	
			FCF			7	

PREVIOUS 4500:00
TODAY 5:50
TOTAL 4505:50
TOTAL LANDINGS TODAY 3

SEE BLOCK A AND AFTO FORMS 781A AND 781B FOR EXPLANATION OF THE STATUS SYMBOL

D — E

STATUS TODAY		BOX NO.	EXCEPTIONAL RELEASE (ENTER BOX NO.)	FLT NO.	COND AFT FLT OK	NO OF DISC	PILOT'S SIGNATURE ENTER AFTER EACH FLIGHT	OVER TEMP ENCTRD	AUX ENGINE OR APU OPERATION
1	7	3	J. Glotz Capt.	1		1	J. Glotz Capt.		
2	8	3	Authur E Hawn Capt.	2		3	J. Glotz Capt.	/	
3	9			3	✓		Authur E. Hawn Capt.		
4	10			4					
5	11			5					
6	12			6					

F GUN OR ROCKET STATUS (INDICATE WHETHER HOT OR COLD AND STATE QUANTITY ON BOARD) N/A.
G ATO BOTTLES INSTALLED ☐ YES ☑ NO QUANTITY
TOTAL TODAY /

AFTO FORM APR 58 781 PART II AIRCRAFT FLIGHT REPORT AND MAINTENANCE RECORD MWM CORP

QUANTITY UNKNOWN

There is nothing that looks so simple as a job well done. It applies across the board—from playing a piano to flying a complicated piece of machinery. The man who does it right makes it look so uncomplicated that many a neophyte tries it for himself, with never a look at the detailed description of how it should be done. we've lost many a crew chief who, deceived by the apparent simplicity of flying, commandeered an aircraft for his own pursuits.

Somewhat less serious in immediate hazard to the man who wields the pencil, is the matter of filling out an "Aircraft Flight Report and Maintenance Record"—the AFTO Form 781 Series. That last sentence was carefully worded. Note that it said, "to the man who wields the pencil."

Just as we've lost people who were deceived by the apparent simplicity of flying, we've also lost people as a result of improperly filled out aircraft forms. It would be difficult to prove that the forms weren't filled out correctly because someone had been deceived into thinking there was nothing to doing the job. But the files are fairly well documented with evidence that there are many, many maintenance troops who didn't know how to do it, and almost an equal number of pilots who didn't know whether it was done properly.

How many pilots are flying an unknown quantity right now?

How many of them can really tell whether they are or are not?

You can hardly find a better example of the need for teamwork than in the AFTO Form 781 Series.

The long and short of it is that if one man does not do his share of the work correctly, the other will not know what he has to work with. Whether he is flying it or maintaining it, there's no good way to work with an unknown. Things are just as bad if you can't interpret what you read, or if you attempt to make an analysis of what is said without reading the whole story. It is equally obvious that if you can't recognize when you're being told all the facts, you're in just as much trouble—or perhaps even more.

Both in humor and in anger, it has often been said that the pilot has gotten to be a fast traveling bookkeeper. The paper work certainly seems to have kept pace with the advancement of technology regardless of whether anything else has or not. But while it might be desirable to have an automatic green light that would come on when the bird is ready to go, and a red one that shows when it's broke, they just aren't there. What's more, they aren't likely to show up tomorrow. We're saddled with a system — paperwork. And the system must be made to work.

The degree to which the system works will depend primarily on how much everyone knows about the job to be done. As machines become more complex, so also does the paper work. At the moment, it may appear that an ultimate of complexity has been reached.

Perhaps one of the best illustrations of this is the response received from all echelons to the article that appeared in the November 1958 issue of FLYING SAFETY. Titled "Change of Form," the article took note of the fact that a new series of records had been brought into being, and a new set of instructions had to be learned. To prove what was said, a series of sample forms were used as illustrations. Each form was full of errors—with malice aforethought.

The response was tremendous, from every rank and from civilian employees. Everyone pointed out errors, *but no one person has yet been able to point out all the errors that appeared!* There were some who had made profound effort to tabulate each fault. Others merely said they were there. Some of the comment is included in the Crossfeed Column.

Even at the time of this writing, six weeks after the issue was distributed, letters are still coming in, proving all over again that no one has learned it all. This is a hard thing to say about paperwork that can spell life or death to the reader. But, judging from appearances, neither pilots nor maintenance men, nor quantity control people have unraveled all the secrets of Technical Order 00-20A-1. All the furor over how to keep the record, and knowing how to read it, inclines one to wonder how well other portions of the T.O. are known and understood.

The record should be the proof of thorough knowledge, and the burden is on us all to show it—every time. ▲

WHAT

"Hello, Anybase Tower, this is Overlord five two. Request landing instructions."

"Overlord five two, this is Anybase. Land runaway seven, winds calm, altimeter two nine point nine six, call three miles out on initial."

Overlord 52, an F-102, turned on initial, called the tower and entered a normal traffic pattern. The new delta winger made an impressive sight as it completed its break and then rolled out on the downwind leg. As the aircraft turned base leg, the pilot called "gear down and checked."

This was acknowledge by the tower. Just before round-out, however, the operator in the tower noted the landing gear was not down. He made a quick grab for the mike but was too late to avert the crash.

The aircraft struck the runway and skidded to a stop. A very amazed and shook Captain made a quick exit from the bent and smoking aircraft.

Major Ben Cautious, the base Aircraft Accident Investigation Officer, was on the scene immediately. He surveyed the wreckage and thought, "This is the fourth gear-up landing in a two-month period. What's the reason? Why? How could a pilot ever forget the landing gear? There's a light in the handle, a horn to blow in the pilot's ear and a set of indicators. All of these things tell the pilot that the gear isn't down."

Well, Ben, there *is* a reason. Let's look into the background of gear-up landings.

First, we'll look at a few Air Force statistics from the Directorate of Flight Safety Research. Back in 1947, only two per cent of all the accidents—or seven out of the 480 reported—were attributed to pilots' forgetting to lower, lock or check the landing gear.

In 1952, there were 22 major accidents resulting from failure to lower the gear and failure to check the landing gear for proper extension. Since 1952, the percentage of gear-up landings has increased steadily.

From March 1956 to March 1957, over 12 per cent of all the accidents were attributed to gear-up landings. One thing not revealed by these figures is the number of instances where pilots have attempted unintentional gear-up landings but were averted by the vigilance of control tower or mobile control unit personnel.

The Air Force is very solicitous about the number of these "forgetting errors" that have resulted in gear-up landings. In fact, the Air Defense Command made this a special study area for the 1957 ADC Flight Safety Symposium. Basically, these accidents result from basic errors in judgment or flying techniques. The greatest number however, involve the misinterpretation of warning signals.

Dr. Neil D. Warren, Professor of Aviation Psychology at the University of Southern California, has pointed out that the failure to actuate a specific control—forgetting to actuate the landing gear—is usually attributed to forgetting errors. Forgetting some part of a well-established habit is a psychological phenomenon that occurs for a variety of reasons. In most cases, well established habits enable a pilot to carry out cockpit procedures automatically with little thought or deliberation. Forgetting the landing gear may occur when something happens to interrupt or momentarily distract the pilot from his normal landing pattern routine.

There are two main factors that cause failures of attention:

• The pilot attends to the "wrong" thing because something has distracted him at the "wrong" time.

• His voluntary or habitual attention to some stimuli, or to some mental process such as memory, so that even strong warning devices are ignored.

By this time Ben was pretty well convinced that a pilot could forget the gear and could ignore the gear warning devices. Now, what can be done about it?

One solution lies in improving the landing gear warning device. The relative attention-getting value of the warning device should be considered from the psychological point of view. A warning signal, such as gear warning device, is one that *must not* be ignored and therefore should be one that *cannot* be ignored.

The gear warning device, as presently installed in our aircraft, provides both auditory and visual warning. The warning horn installed in many of our aircraft has sufficient volume to be heard by the pilot; however, because of interference, distractions, attention errors and the monotonous tone of the horn, it can be overlooked. The warning lights that indicate to the pilot the landing gear is not down and locked can go unnoticed unless a pilot specifically looks at the gear handle. This steady warning light has little "attention getting" value, since there are numerous other cockpit lights which activate during flight. These are fuel low warning, radio beacon and radar operating lights, to name a few. During the landing period, the pilot's attention is primarily focused on looking at the runway and on the Mach meter-airspeed indicator or airspeed indicator. The presently installed landing gear warning devices do not provide sufficient stimuli to alert the pilot to the fact that he is performing a gear-up landing approach.

GEAR?

Major Eugene Martin, Jr., Flight Safety, Headquarters Air Training Command.

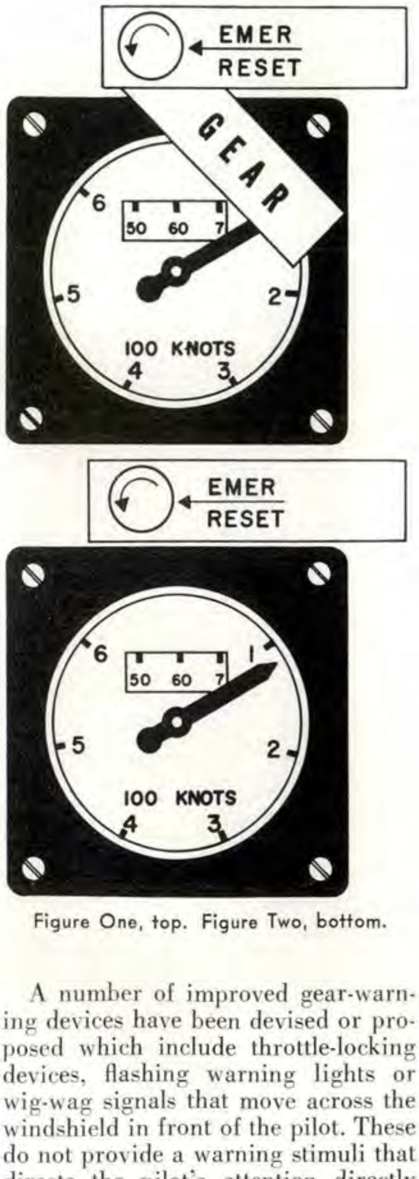


Figure One, top. Figure Two, bottom.

A number of improved gear-warning devices have been devised or proposed which include throttle-locking devices, flashing warning lights or wig-wag signals that move across the windshield in front of the pilot. These do not provide a warning stimuli that directs the pilot's attention directly to the landing gear. Also most of these devices could be overlooked by the pilot.

The solution to this problem lies in the design of a warning system that cannot be ignored. This could be provided by a landing gear warning system which would consist of a solenoid operated flag on the airspeed indicator (Figure 1), or by installing a variable frequency audio oscillator that would produce a warble sound in the pilot's headset. This system would be actuated when the aircraft's indicated airspeed has dropped to slightly above approach speed, and the throttle retarded to approximately final approach power and the landing gear is not extended.

The visual portion of this warning system would provide a very definite attention stimulus. Since the airspeed indicator is the primary instrument during the landing phase, any device which would partially cover the airspeed, as this flag device does, would bring immediate attention to the pilot. By placarding the gear warning flag with the word GEAR it would give the pilot a direct reference rather than have to use a process of association as in present type gear warning indicators.

Now, let's see how this system would actually operate from the pilot's viewpoint. As the pilot enters the traffic pattern, power is reduced. As he slows the aircraft to approach speed, the visual flag would drop over the Mach meter-airspeed or airspeed indicator if the landing gear is *not* extended. The pilot would also hear the warble warning in his headset.

When the landing gear is lowered, the landing gear micro switch would break the circuit, the warble signal would cease, and the flag over the airspeed indicator would retract to the position shown in Figure 2. In the event the pilot is required to land gear-up due to an emergency, provision could be made to manually lock the airspeed flag in the retract position.

One major advantage to this system is that when making reduced throttle instrument penetration or descents, the warning system would not be actuated because of the high airspeed which would not allow the warning system to be activated.

In the gear warning system used in present jet and conventional aircraft, the pilot often hears the warning horn during descent and penetration. It therefore loses its attention-getting value and often is ignored.

The airspeed flag and audio warning device could be adapted to all present jet and conventional aircraft using the existing gear warning circuits. Weight of the warning device could be held to a minimum through transistorized circuits in the audio oscillator. The airspeed actuating flag solenoid would only weigh a few ounces. Actuation of the flag and audible portion of the indicator would be triggered off through commercially available switches that sense decreased airspeed and attitude. These switches can be set for air speed from 175 to 250 knots and set for altitudes of from 5000 to 12,000 feet.

This approach to a new gear warning system provides a warning system that cannot be overlooked.

You and I, and especially the Accident Investigators like Ben Cautious, must realize that unintentional gear-up landings have taken their toll of the Air Force operational aircraft and have created a very high dollar loss. All commands are concerned with this problem. With this in mind, we can all see a very definite need for improved landing gear warning devices that can be retrofitted in our present day aircraft and designed into the new ones on the drawing board. ▲




• Tips For T-Bird Drivers •

Major Wallace W. Dawson, Fighter Branch, Flight Safety Research.

The U. S. Air Force pilot flies the best airplanes in the world. Our uncle spares no expense to give us the best equipment that money can buy, produced by the best brains available. But let's face it—any piece of machinery that has a job to do is subject to failures or malfunctions no matter how good it is. That's why at times parts of the machine go awry and don't do their assigned job. One of those parts that can malfunction, and does upon occasion, is the most excellent slaved gyro magnetic compass system.

As is commonly known by one and all, this superior direction indicating system has proved itself over thousands of hours of satisfactory operation. However, in order for the system to give us dip, lag and precession free indications it must necessarily be pretty complicated. This complication coupled with the criticality of the necessary electrical voltage to make the system operate can lead to malfunctions.

Although the chances of your losing the slaved gyro and Radio Magnetic Indicator (RMI) are remote indeed, it is well to know what to expect and what can be done with what is left. Actually, the main thing to remember is that there is no sweat. You *could go* clear across the good old U.S.A., sans slaved gyro and RMI and always be right on course, if you had to.

The slaved gyro and the RMI both receive their indications from a single, direction sensing system so if trouble occurs anywhere in the system, both electric compasses will give the same erroneous indications.

One common malfunction is blowing of a $\frac{3}{4}$ amp fuse in the transmitter unit. With this fuse blown, the circuit is interrupted and the compasses are no longer "slaved" to the earth's lines of magnetic force. Without this slaving action, the compasses will follow the principles of a free gyro in space.

A free gyro will drift, due to gimbal ring unbalance, precession, rotation of the earth and bearing friction. Consequently, the error between the electric compasses and the standby magnetic compass will increase as the flight progresses.

If the slaved gyro, the RMI and the magnetic compass all agree before takeoff but later a good sized difference appears, naturally you should land as soon as possible and get it fixed. If, when you notice the difference, you just have to go on through to get to some place to land as soon as possible, here's how you can do it.

Don't trust the headings of the slaved gyro and the RMI; use only the standby magnetic compass for heading information. The electric instruments can be used like the old directional gyro however, when you need to make a turn of a certain number of degrees. This can be hard to do on some headings on the mag compass alone.

Also, and this is important, the vertical bar of the ID-249 will still operate normally. In other words, set up the desired radial in the course window of the ID-249 and, using the magnetic compass for heading information, turn the aircraft to intersect this radial. As usual, when you are on the radial, the vertical bar is centered.

The Number One needle of the RMI which is hooked up to the bird dog is not affected in any way; it still points to the station tuned in.

The Number Two needle of the RMI points to the correct heading that will make good a course to the Omni station tuned in but, and it's a big but, the RMI card is not indicating the correct heading of the airplane as we have proved by checking it with the standby magnetic compass. So where do we stand?

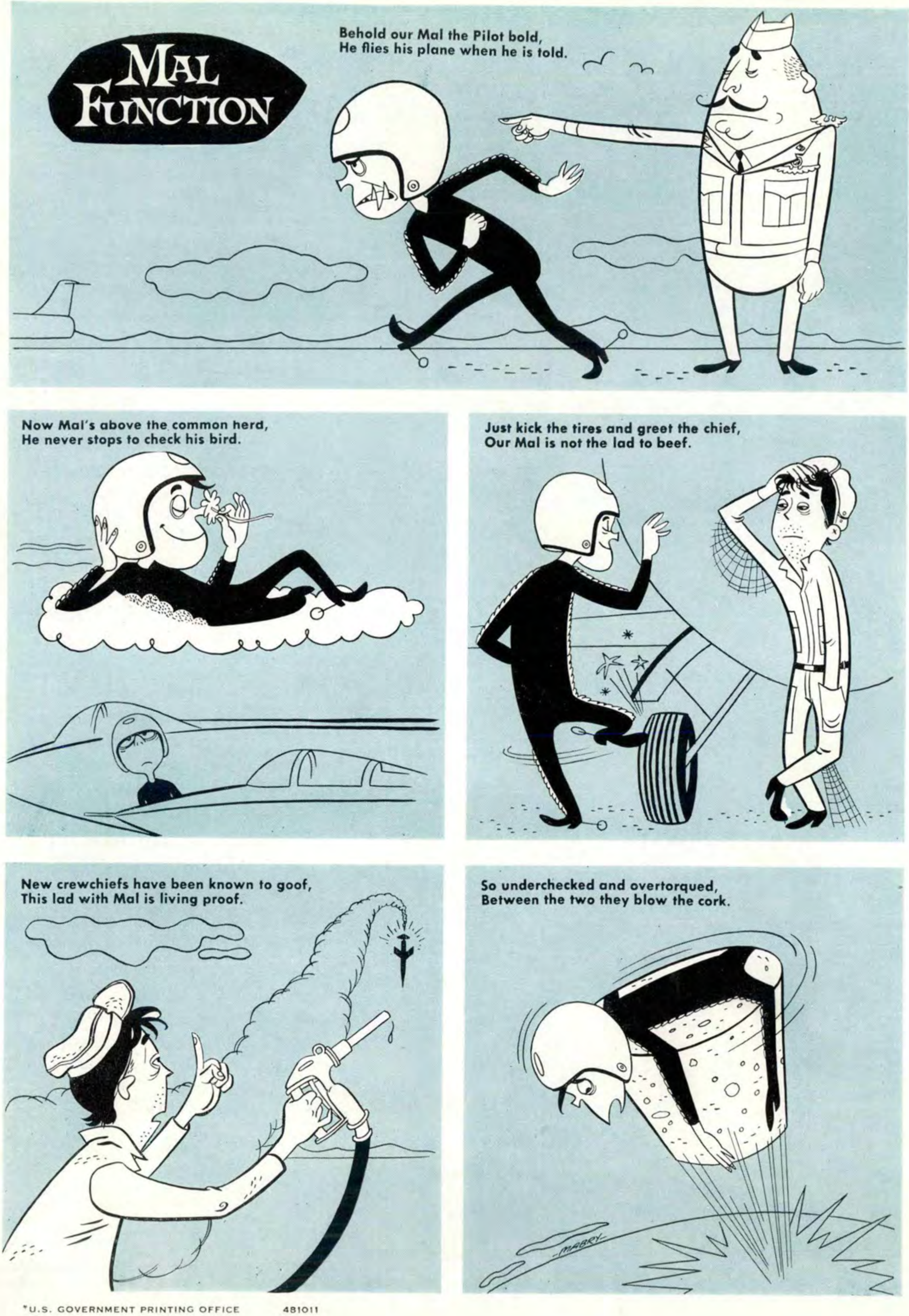
Set the desired course in the course window of the ID-249. Using the standby magnetic compass for heading information, turn the aircraft to intersect this heading. The slaved gyro and/or the RMI can be used to measure the *amount* of turn, but don't trust their headings. As long as the vertical bar of the ID-249 is centered, you are on the radial you have selected.

When you get close in, turn on the bird dog and line up the Number One needle; it will point to the station. Land as soon as possible and get it fixed.

So, if you look down some fine day and the magnetic compass doesn't agree with either the slaved gyro or the RMI, don't panic. Just use the foregoing procedure and you'll not only get there safely, but you may learn something to boot! ▲

Since 1820, historians, savants, sculptors and art students have been engaged in speculation about the original position of Venus de Milo's arms. We believe that the photographer who did this study might be just as right as anyone in his interpretation. At any rate you must admit that the effect is pleasing and Julia Adams was never more beautiful.

Until the arms are also found on the Island of Milos in the sunny Sea of Crete, people will speculate on the unfortunate incident that lost the arms of the Venus. It could have been that some ancient warrior captain was entrusted to hide the statue of the Goddess when some enemy sail appeared on the horizon. We can picture him taking his detail of men, removing Venus from her pedestal, and hastily transporting her to a hidden cave. In the confusion, proper safeguards were not observed and the arms were shorn away and cast aside. It is always thus when haste is substituted for good procedures. A valuable property is damaged and the people left behind must suffer—even as they suffer as a result of aircraft accidents.



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