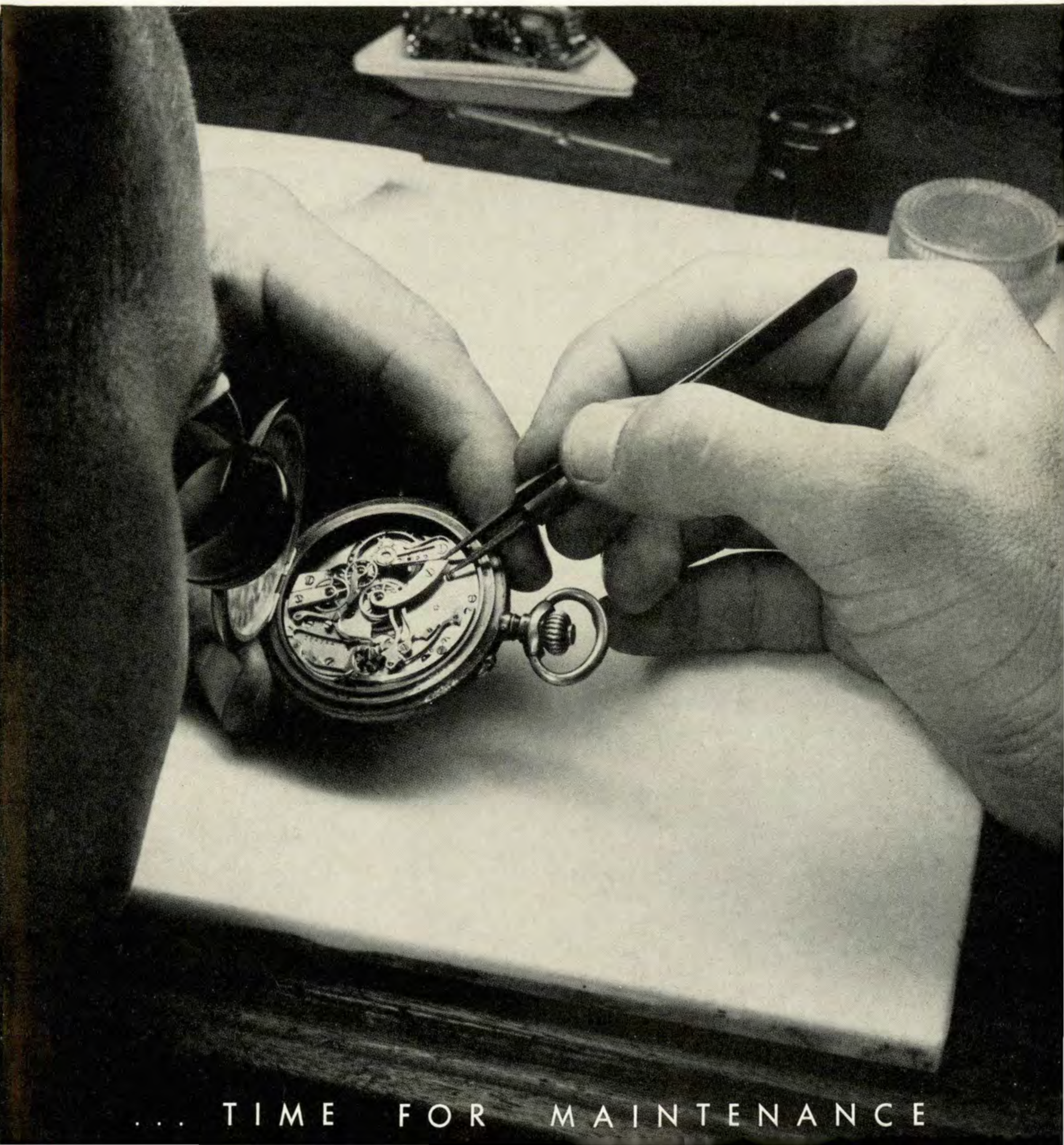
NOVEMBER 1958

FLYING SAFETY

UNITED STATES AIR FORCE



... TIME FOR MAINTENANCE

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Symbolic of maintenance is modification center of SBAMA.

THE EDITOR'S VIEW

Accidents have been described as events frequently descended from a long line of advice not listened to. In tracing the genealogy of disasters, one is struck by the truth of the statement. Those of us who have been around the Air Force for a while can recall parallels to almost every accident that occurs. With little effort one can trace the accident that occurred today to the first one that happened to a military plane. Fifty years ago it happened. "One of the propellers broke, the machine being at that time about 75 feet from the ground. The machine side-slipped and nose-dived, striking the ground with such force as to fatally injure Lieut. Selfridge. . . . Cause of accident: Breaking of propeller and consequent loss of lift."

Small difference between that event, and one involving turbine blade failure on takeoff. Both boil down to cases of inadequate inspection, maintenance, design or materiel. We are hardly so naive as to suggest that because a propeller failed in 1908, we should not expect it to happen again. Quite the contrary. *Because* that prop failed fifty years ago, we can expect it to happen again and again and again, provided we do not take positive action to stop it.

That was the indicator, just as there have been original indicators for all the other sorts and types of aircraft accidents since that day. Action was recommended as a result of that accident, just as action has been recommended since. But to many, the recommendations were meant "for someone else—not me." In our wholesale scale of doing business now-a-days, whole commands have sometimes said the same thing. . . . "It is somebody else's problem."

Recommendations coming out of aircraft accident investigations are bits of advice which, if followed, will prevent accidents in the future. Lip service to the problem, or waiting for someone else to take action will not save one broken machine. For although it may be true that few of us can remedy a materiel or design hazard for all time to come, every one of us can do his part to improve the condition until the big change comes along. It is usually a simple task, that of knowing what has caused accidents before, and being vigilant and careful to see that it never happens again. Broken down into its simplest form, this means *thorough* preflight inspections, operating *within* established limits, and *complete* postflight reporting.

CROSSFEED

LETTERS TO THE EDITOR

Who-Who-Who?

In the September issue of FLYING SAFETY, a picture of a lovely young blond appeared on the inside face of your magazine cover to carry home a particular point concerning flying safety . . . that most things of real and lasting value do not come without some effort.

The point was so well and so cleverly carried home that I became more and more interested with my contemplation of that fact.

I would like to have any information available concerning her name and her mailing address, and/or an address where she may be reached by correspondence.

HOWARD L. BODENHAMER
C/3C, USAF

★

We've had numerous inquiries from members of both the reserve and active duty units at this station as to the identity of the young lady whose picture appears on the inside back cover of the September issue of FLYING SAFETY.

I would appreciate your forwarding this identification data for possible future action in making this young lady an honorary member of this unit.

1st Lt. John N. Nienstedt, USAF
Administrative Officer, Det #2
2578th ARFC (CONAC) USNAS
New Orleans, La.

I give up. Name is Venetia Stevenson, Star of Warner Bros. Studios.

★ ★ ★

Team Member

I am a very ardent fan of FLYING SAFETY, and your articles on the Flying Safety Officer and the accident-prevention job he is doing is of great value to pilots and maintenance men alike. But, what about the man behind the Flying Safety Officer? I am referring to the administrative man.

I am currently assigned to a non-tactical headquarters in the Canal Zone. Before coming here I was the administrative man at a tactical outfit. I performed all the administrative work on aircraft accidents, incidents and operational hazards. When I say performed, I mean all the typing and filing. Taking a major aircraft accident report down on a wire recorder and then transcribing it back into readable form is a job I wish on no administrative man.

The FSO deserves all the credit that can be given. But, how about recognition for the administrative man?

Name Withheld By Request—

Stand and be recognized, all ye typists. We need you. Keep up the good work.

A Vote for Humor

NEGATIVE on the "Too Much Humor" comment in Crossfeed, September issue. The flying game today is so overburdened with detail and control that your magazine, with its informal approach, is a breath of fresh air.

I don't advocate going back to the "Good Ol' Days" of listening to football games as you homed your way around on a weekend cross-country, but let's keep our perspective and our sense of humor in this era of the scientific airplane driver.

Don't make the business any more serious and pallid than it actually is. Thanks for a good magazine.

Capt. Tom M. Skillman
Flt Ops Office, AFROTC Det 770
Clemson College, S. C.

★ ★ ★

. . . another Yes

I believe he'll admit we already have a tolerable number of "bibles," i.e., AFRs, AFMs, Dash Ones, Policies, SOPs, Stand Board booklets, Accident Reviews, Letters from CAA, Major Air CO's, Base CO's—just to mention a few.

We (the younger AF pilots) need FLYING SAFETY as it stands! i.e., Something we can read easily, like a magazine, not a bible; something to catch the eye and attract attention; something that we can learn and absorb and retain over a long period of time. All these situations are much more evident in comic or illustrated form, as you and your staff well realize.

Has the Colonel ever heard of *Training Aids?*

1st Lt. John R. Ziegler
3610th NTS (F/S)
Harlingen AFB, Texas

★ ★ ★

. . . And a No

. . . Perhaps there has been a little too much humor in your magazine.

Sometimes many of us overlook the fact that the very qualities that are associated with the man who runs a strictly disciplined organization are also those qualities that achieve real safety.

A. S. Invicta
Aviation Safety Engineer
Los Angeles, Calif.

★ ★ ★

Wheels, Brakes and Struts

We are concerned by the high losses of or damage to wheels, brakes and struts caused by landing accidents.

The wheels, brakes and struts on later type cargo aircraft are considered Hi-Valu items because of the high usage rate more than because of the cost. Since accidents contribute to the high usage rate, this factor must be considered in the control of these items. It follows that a reduction in the number of landing accidents would result in a decrease in the usage rate and a corresponding decrease in the cost of those items.

The series of articles in the May 1958 issue of FLYING SAFETY pointed up the necessity of proper landing techniques. We notice that a series of such articles usually follow the introduction of new aircraft and are usually prompted by a rash of accidents. A large portion of landing accidents occur during the period when a new aircraft is being activated and when a majority of the pilots flying them are in the transition period. We feel that many accidents could be eliminated by publishing the information prior to activation of the aircraft. Having pilots learn what constitutes improper techniques the hard way is extremely costly.

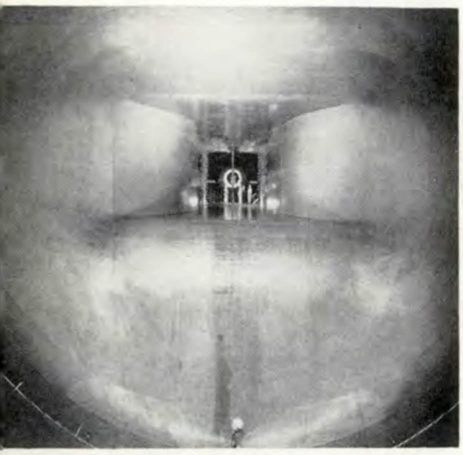
A majority of pilots learn to fly a new aircraft by the book and although they're aware of the "dos," they are not sufficiently aware of the "don'ts." The "don'ts" are uusally published as the result of the findings of accident review boards, after they have been discovered the hard way.

The Flying Safety articles usually indicate that sufficient information is available prior to activation of an aircraft to preclude the learning of aircraft limitations by reading accident statistics.

We suggest that a possible answer to the problem is a review of the Dash One Handbooks. Possibly more "tricks of the trade" could be included and more emphasis placed upon the results of improper techniques. Transition training should include not only the "how" an aircraft is landed, but "why" it must be landed in a particular way. We realize that it is impossible to make a handbook absolutely fool-proof but we also feel that more emphasis should be placed on the results of improper techniques and what constitutes improper techniques. Knowing what an aircraft will not do is as important as knowing what it will do. We feel that no pilot can know too much about the performance of his aircraft, particularly when he is landing it.

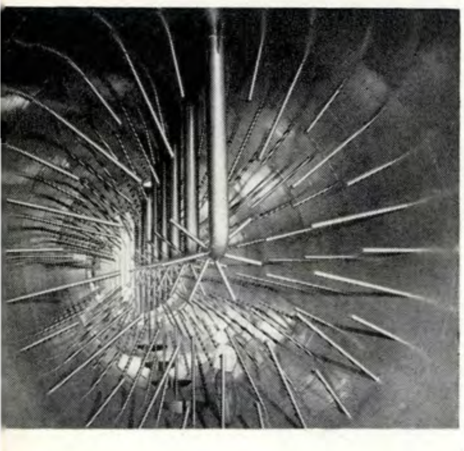
Max K. Kennedy
Technical Associate
Maintenance Engineering, OAMA
Hill AFB, Utah

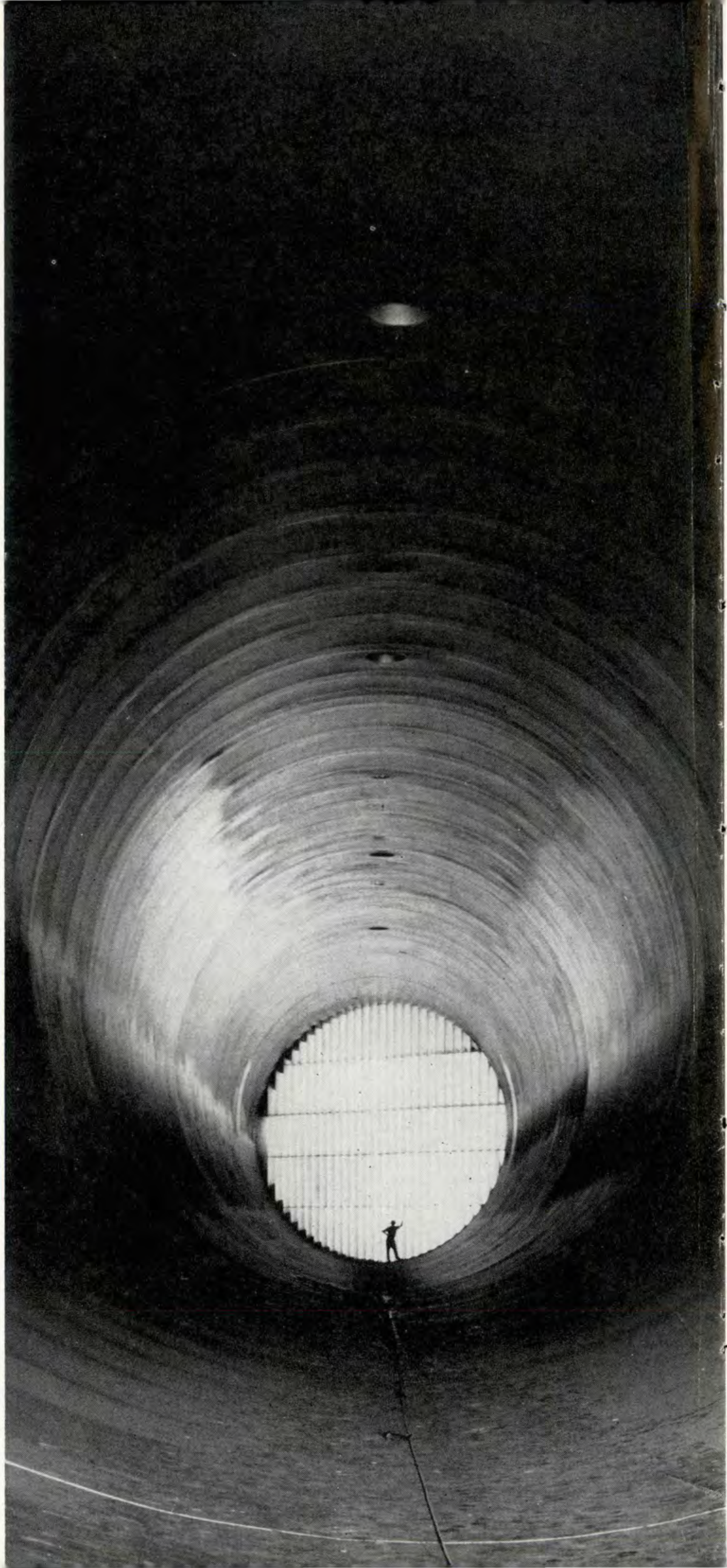
Experience is a great teacher. But we could make a lot of progress by having pilots know and believe what is already in the book. We'll keep reporting the "tricks" as we hear of them. Contributions are welcome.



Looking down the barrel—transonic circuit of Propulsion Wind Tunnel.

Compressor to power and spraybars to cool airflows, 0.5 to 1.5 Mach.





Jack Shea, Special Assistant to Managing Director, Arnold Engineering Development Center, ARDC.

Numbers, Tunnels and Time

Air view shows Gas Dynamics Facility, left foreground, Engine Test Facility, right center, Propulsion Wind Tunnel trans- and supersonic beyond.

As the complexity of modern flight devices increases and performance flirts with the temperature and pressure extremes of high altitudes and supersonic velocities, the critical numbers have increased in importance.

Limiting numbers for today's and tomorrow's aircraft, engines and missiles are being determined in the Air Force's unique wind tunnel center at Tullahoma . . . Tests in AEDC's high-altitude engine test cells and advanced wind tunnels help speed development of top performance weapon systems . . . assist in solving many pre-flight problems.

The Century fighter was too fast entering the initial. Indicating almost 400 knots over the runway, the pilot chopped it to idle, popped dive brakes and pulled 4G on the break. Still 50 knots above gear-down speed on downwind, he dropped gear and flaps and sucked it around into a nice tight base.

Too steep on final? He worries not. "Just extra airspeed . . . 40 knots should do." . . . Over the fence and horsing back on the stick drops it in, indicating 190 forward and about the same downward.

Captain O'Toole, the maintenance officer, winced as the fighter jockey popped the drag chute and stood on the brakes to make the second turn-off. He dourly noted the smoking brakes and the slightly bent fairing on the left gear as he circled the fighter while waiting for the pilot to complete the form.

"Hey, Mac," he yelled to the pilot climbing out of the plane. "I observed that performance with deep interest. Ever think about insurance?"

Lieutenant MacLeod grinned. "Insurance? I've *got* insurance. If I had money like I've got insurance, I'd retire tomorrow."

"Okay, Mac, you got insurance," said O'Toole as he accepted the cigarette. "But I'm talking about a different kind, the kind that Uncle Sugar and the manufacturers are trying to build into these birds. I'm talking about the numbers these people come up with, the maximums and minimums that the engineering types spell out so you can get the most out of that beast, and still come back in one piece."

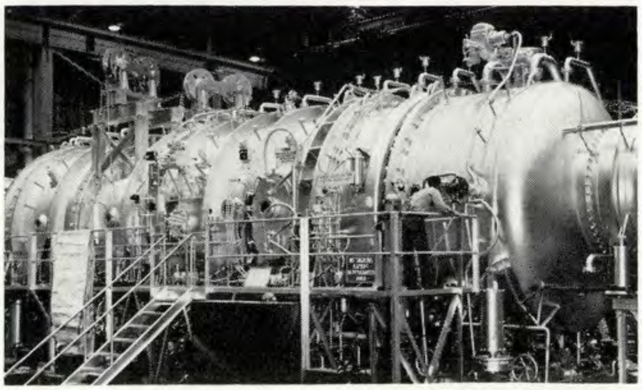
O'Toole spoke of great truths. For as the complexity of modern flight devices increases and performance flirts with the temperature and pressure extremes of high altitudes and supersonic velocities, the critical numbers have increased in importance. The comfortable "fudge factors" of WW II are a thing of the past as thrust vs. weight vs. structures vs. loadings, pyramids the elements that balance safe operation with top combat performance.

And great effort is placed upon determination of these "numbers." Exhaustive tech reports analyze aerodynamic and propulsion problems years before the first X-models fly. Hundreds of hours of testing precede first flight. This still doesn't detect and solve *all* the problems; but it helps hammer out many serious bugs and sets some guide lines to follow.

Some of the most valuable "numbers" are being produced by the Air Force at its Arnold Engineering Development Center near Tullahoma, Tennessee— the wind tunnel center of the Air Research and Development Command.

Working with project engineers from aircraft, engine and missile contractors for all of the armed services, the personnel of the AEDC are turning out great volumes of data, graphs, reports, tables and film records that determine the red lines, the structural limits, the maximums that govern safe maintenance and operation.

Above, Engine Test Facility Engineers watch test on closed circuit TV. The High Altitude Test Cell, below, tests turbojets, ramjets, rockets.



From the air, AEDC looks like a plumber's nightmare. This test tube for future flight is a maze of pipes, huge circuits of ducting, overhead cranes and heater stacks. High power transmission lines—source of electrical power from the TVA—lend a bizarre look to the functional maze.

Located amidst a 41,000-acre tract that was the Camp Forrest military reservation during World War II, the AEDC has about 20 various test cells or test sections ranging in size from a foot-square to 16-foot monsters which can accommodate full-scale models of aircraft, missiles or engines mounted in flight-type installations.

There are three major facilities:

The Propulsion Wind Tunnel — for aerodynamic or combined aerodynamic-propulsion, testing of aircraft, missiles and space weapons. Currently in use is the transonic circuit which tests weapon systems form Mach 0.5 to Mach 1.6 and from sea level to well over 100,000 feet. Under construction is the supersonic circuit which will have the capability to test from Mach 1.5 to about March 5.

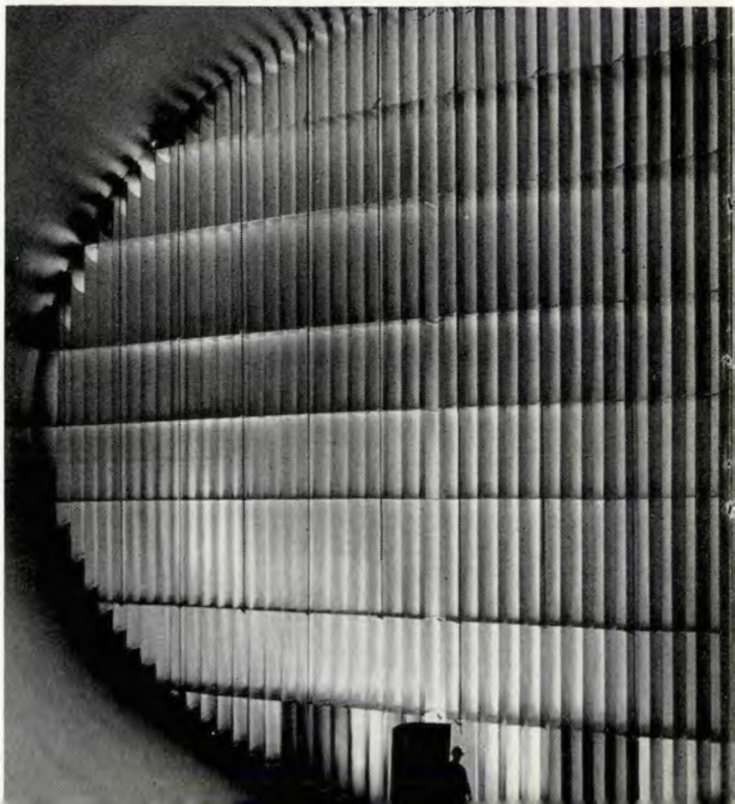
The Engine Test Facility—for testing rocket motors—liquid and solid propellent—and turbojet and ramjet engines from Mach 0.5 to Mach 4, with temperatures from minus 120 degrees F. to plus 800 degrees F., and at altitudes up to more than 100,000 feet.

The Gas Dynamics Facility—for aerodynamic testing of advanced aircraft, missiles and space weapons. Ranges here cover Mach 1.5 to Mach 5 (supersonic); Mach 5 to 10 (hypersonic) and Mach 10 to 20 and beyond (far hypersonic).

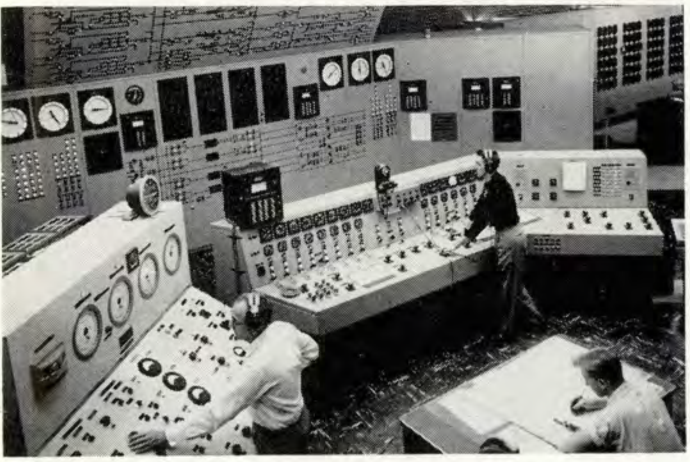
All three laboratories generate huge volumes of airflow, carefully conditioned as to temperature, density and velocity, and direct it through engine test cells or wind tunnel test sections in which models or full scale aircraft, missiles and engines are mounted on special supports.

It was constructed under the supervision of the Tullahoma Engineering District, U. S. Army and is operated by ARO, Inc.

Giant turning vanes direct airflow smoothly around corners of circuit.



Heart of the system is control. Above, Main Control Room for Propulsion Wind Tunnel. Below, Control Room for Engine Test Facility.



The items being tested have hundreds of instruments installed in them. As each test data point is established, these measure and record temperatures, thrust, vibrations, pressures, take photographs internally and externally of what is happening, and provide information as to the adequacy or inadequacy of design, operation and components.

Instead of flying the hardware through the air, air is being blown past or through the test article. The test flights are being performed on the ground. But this does not mean that the day of flight testing is drawing to a close. The flight test types still have their work cut out for them. AEDC's effort is to *assist* them: Assist them by providing more information, more promptly, before the complex power plants and airframes of the aircraft reach flight test stages.

And—for missiles and space weapons—this means that the chances of successful launch and flight are more assured when rocket motors and controls are checked out on the ground under realistically-simulated high altitude conditions. During 1958, AEDC's testing of rocket motors has increased sharply, and problems that had never been encountered in sea level firings have been detected and observed first hand.

"We are not trying to put the flight test people out of business," says Lt. Col. Bob LeBeck, USAF Representative at AEDC's Engine Test Facility, in describing test cell work.

"High altitude, supersonic test cells have a lot of advantages, but the final proof must be determined in actual flight.

"We can set up conditions that match flight under the most rigorous conditions, and we can run the engine for hundreds of hours, taking literally millions of data measurements in a lot less time than we could ever get this much experience in flight. And, in the case of ramjets, we can do this with the less-expensive 'boilerplate' engines before the flight-weight units are built and finally tested."

"However," he says, "there will always be problems that have to be discovered and defined in actual flight. And when these problems are encountered we can simulate the conditions under which they were encountered and set about to investigate the cause and help determine the fix.

"It is our endeavor here at the Arnold Engineering Development Center in the Engine Test Facility and Propulsion Wind Tunnel—in cooperation with the engine manufacturer—to produce a fully-developed or proven power plant system so that when flight tests of the airframe are conducted these tests may be entirely devoted to the airframe. In other words, the pilot should, in the ideal case, not have to worry about the power plant's working and he can concentrate on the flying characteristics of the airframe only."

The test cells' work may be divided into four major areas: investigations of speed, altitude, temperature and attitude.

Typical jobs in these categories are:

SPEED: Determining operational efficiency of combustors, turbines, flameholders . . . detecting internal flow irregularities . . . establishing specific thrust, fuel consumption, stability of combustion and burning failures or "blowouts" . . . determining reliability of afterburners and checking control systems.

ALTITUDE: Investigating the effects of various altitudes on combustion limits and reliability, fuel efficiency and operation of components . . . on re-ignition after blowout.

TEMPERATURE: Determining the structural limits of engine and its control systems under extreme temperature variations—the effects of temperatures on specific thrust, fuel consumption and other operation.

ATTITUDE: Investigating internal flow irregularities due to changes in angle-of-attack; determining the optimum inlet configurations; simulating distortions generated by shockwave reflections from fore parts of the aircraft during various flight attitudes.

But, perhaps the best and briefest way to describe the Arnold Engineering Development Center is to report some typical examples of its work—as specifically as security permits.

The J-47 Turbine Failure: Two J-47s were subjected to altitudes and velocities substantially beyond those possible for any aircraft the engine powers. However, these flight conditions were still considered to be within the engine's operating envelope.

At almost identical conditions both engines failed. Major damage resulted as the turbine wheels broke up and tore the engines to pieces. The instrumentation indicated an uneven temperature distribution; and, as a precautionary measure, the manufacturer and AMC dispatched a "fix" kit to all units equipped with these models of the engine.

The test cell designed to withstand the explosive failures, was back in operation in a few days.

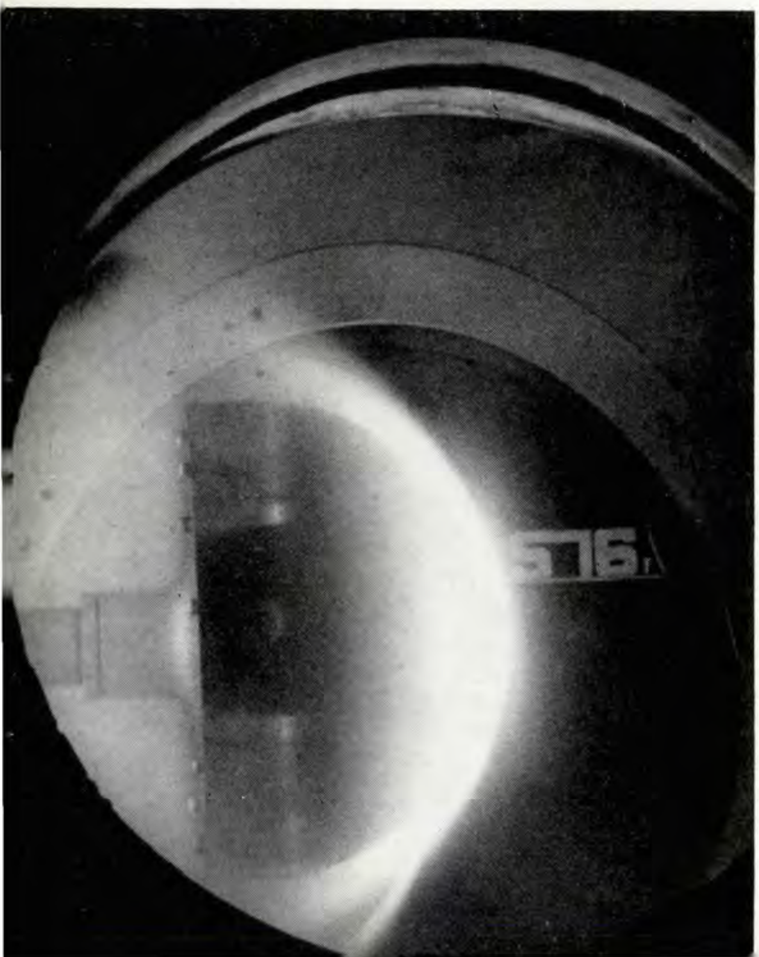
B-58's J-79 Cooling—A full-scale engine pod installation was checked out at AEDC almost a year before the first flight of Convair's Hustler. The engine, in its pod, was operated under various temperatures, speed and altitude conditions to check the adequacy of its cooling system under critical supersonic flight conditions.

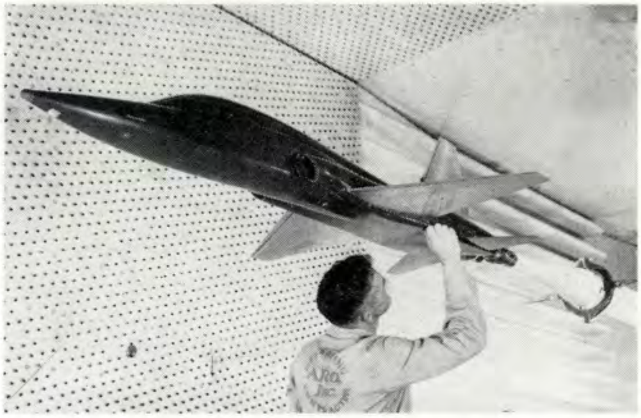
Nozzle Vibration—One recent turbojet, under sea level test runs at the manufacturers' plant, displayed a serious vibration in the nozzle under certain power settings. The engine was slated for installation in aircraft scheduled to roll off production lines in a few months. The problem was brought to AEDC and a special program run to determine the cause of the vibration. This pointed the way to an acceptable fix. Result: Prevention of grounding or delaying delivery of a new aircraft.

Afterburner Instability—One current turbojet developed combustion instability during recent tests. The result was a rugged "cycling" of thrust variation somewhat like switching the afterburner off and on every two seconds. Thrust variations would have alternately jarred the pilot back against the headrest, then thrust him forward on his shoulder straps. Test data, plus color motion picture films made through a tailpipe periscope, provided information which permitted a modification of afterburner and stable operation was achieved before this potentially fatal condition was encountered in flight.

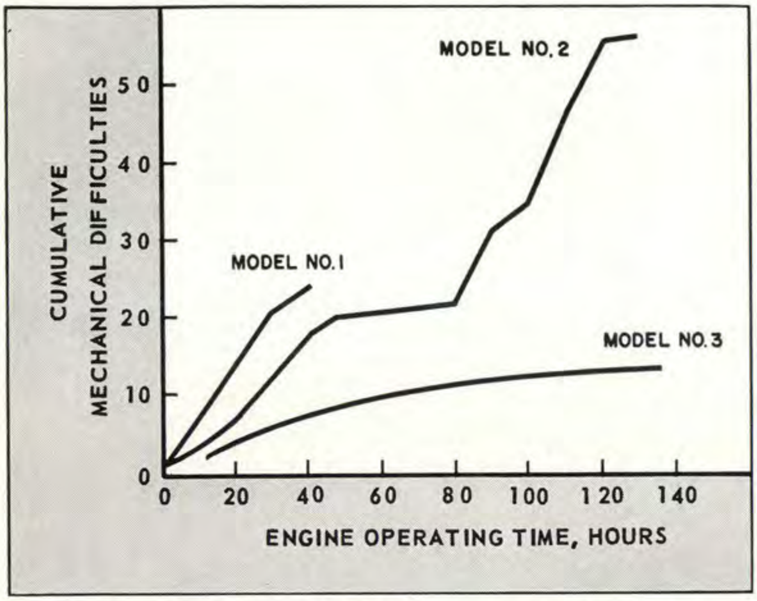
Fuel Valves—A turbojet, currently operational, underwent development testing at AEDC about a year ago. Valves which controlled afterburner lightoff and thrust control seemed reliable during sea level tests. However, under high altitude conditions, and when subjected to valid flight temperatures, both proved to be inadequate. Test information helped the manufacturer revise the valves for dependable operation.

Arc-driven wind tunnel, test models are subjected to extreme speeds.





Above, Model of T-38 supersonic trainer is mounted for testing in the transonic section of Propulsion Wind Tunnel. Below, jacks set flexible nozzle section of tunnel which controls velocity of airflow to model.



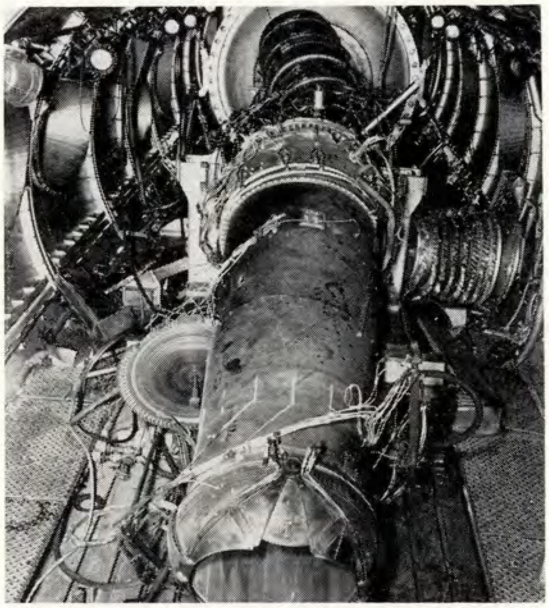


Chart shows number of mechanical difficulties encountered during development of sample engine. Subsequent tests on same type engine fixed as required result in longer engine life and greater reliability which can result from test cell work. Failures, multiple and extreme, do occur!

Altitude Re-start Limits—Establishing a safe re-start envelope in flight tests is a time-consuming and hazardous job. When difficulties of this type were encountered with one turbojet recently, a special 14-hour program mapped the safe re-start limits at a variety of high-altitude and flight speed conditions. With this information at hand, and with properly adjusted engine controls, the pilots could successfully re-start after flameouts.

To have plotted similar data in flight tests might well have required almost 30 days of hazardous experimental flying for as many as 10 aircraft.

But these are just a few of the major jobs at AEDC. Hundreds of lesser incidents become important factors in any engine development program.

These range from a defective spark plug to a control failure which would have aborted a test flight or made an emergency landing necessary. However, in test cells, engineers frequently spot a number of mechanical bugs and give the manufacturer information for modifications which result in a more reliable power plant.

Besides propulsion work, AEDC's test work involves a number of top-priority aerodynamic development programs. These comprised mostly of work on ballistic and aerodynamic missiles and space weapons in the hypersonic and far-hypersonic regions.

However, some examples of work in the transonic and supersonic areas illustrate the Center's typical contributions to aircraft development.

Republic F-105 Inlets—Several years before the first experimental F-105 made its initial flight, a small scale model of the fighter inlet was tested in an AEDC tunnel. Data permitted Republic's engineers to calculate reliably the most efficient inlets for the aircraft. This substantially increased the performance capability of the F-105s now in production.

T-38 Flutter and Aeroelastic Tests—Typical of the whole series of flutter tests now being performed on aircraft in the developmental stages is the recent work on the Northrop T-38 supersonic trainer. In these tests, scale model wings of the aircraft (usually one wing mounted on a half fuselage), are used. They have the same degree of structural stiffness or flexibility that the full-scale aircraft will have.

The models are subjected to the critical transonic velocities to determine if the wing configuration develops any undesirable tendencies to flutter within the operational envelope of the airplane.

Aileron reversal is one of the areas investigated in the aeroelastic tests. And, as in flutter, the information is a guide for the designers. With it they can prescribe a minimum-weight (optimum-performance) aircraft that will still be structurally safe.

The examples cited are representative of the work in the propulsion and aerodynamic areas, but there are literally hundreds of additional examples that could be reported.

Jobs like determining a safe manner in which to separate a store from an aircraft in supersonic flight; studying the effect of high-speed wind blasts directed at instrumented dummies dressed in various types of flight gear; investigating the static and dynamic stability of a hypersonic missile as it is launched and accelerated through various altitudes to supersonic and hypersonic conditions.

Each test project involves new challenges. Completely new testing techniques and equipment have been developed to meet these challenges and probe new and unexplored regions in the frontiers of flight.

Yet, in all the work, one single theme remains predominant. That is the goal of providing "insurance"—the numbers—that are key factors in developing the nation's airpower of today . . . and . . . tomorrow.

For pilots and aircrews this is life insurance. Life insurance in two ways:

- To provide for their personal safety by determining adequate structures and reliable performance.
- To provide them with the combat superiority required to accomplish a mission and return to fly again. ▲

So there you are, quite pleased with yourself, your airplane, the weather and everything in general. You are cruising at 40,000 feet, about two hours out, on a navigational training flight. The weather has improved rapidly since you broke out on top at 35,000 feet. Now you can see the ground most of the time and your destination is forecast to be CAVU. What's better than that?

The two jet engines are performing perfectly, all the engine instruments steady. You have made a couple of checks on your ground speed. It is exactly as estimated, for, wonder of wonders, the winds are as forecast. And you are especially proud of yourself because of the care and completeness you used in planning the flight.

You have not bothered to monitor the fuel consumption closely since you expect to have 3000 pounds remaining at destination, which is more than enough. But finally you decide to make a fuel consumption check to help bolster your ego. There's really no doubt that your cruise performance is the same as that which you calculated from the Pilot's Handbook data. Oh yeah? In the last thirty-six minutes you used 2100 pounds of fuel. You figured you should have used only 1700 pounds! What could have happened? You know that the flight was planned perfectly, according to the Pilot's Handbook data. At least you think it was.

Your next thought is that the Handbook is wrong. You lose all your confidence in the published performance data and know full well that all those hours spent last night studying the cruise data in the Handbook were wasted. You think the Handbook betrayed you—but did it?

You recall the planning of the flight? The takeoff and climb data are probably correct, you concede, since your calculated figures corresponded perfectly with your actual flight results. The ground speed is as planned so unexpected winds can't be your trouble. And your true airspeed indicator is locked on the recommended cruise of 40,000 feet according to the true airspeed figures in the cruise curves.

You feel you are fortunate to have an airplane with a true airspeed indicator to simplify cross-country flying. Little do you know that your present fuel worries are caused by that very instrument. In all your careful studying last night you misinterpreted the cruise curves.

You determined the true airspeed for the recommended cruise directly from the true airspeed scale at the bottom of the curves. Then during the flight you used the power setting which was necessary to fly at this true airspeed. This procedure would have been okay if the temperature of the air at 40,000 feet was standard.

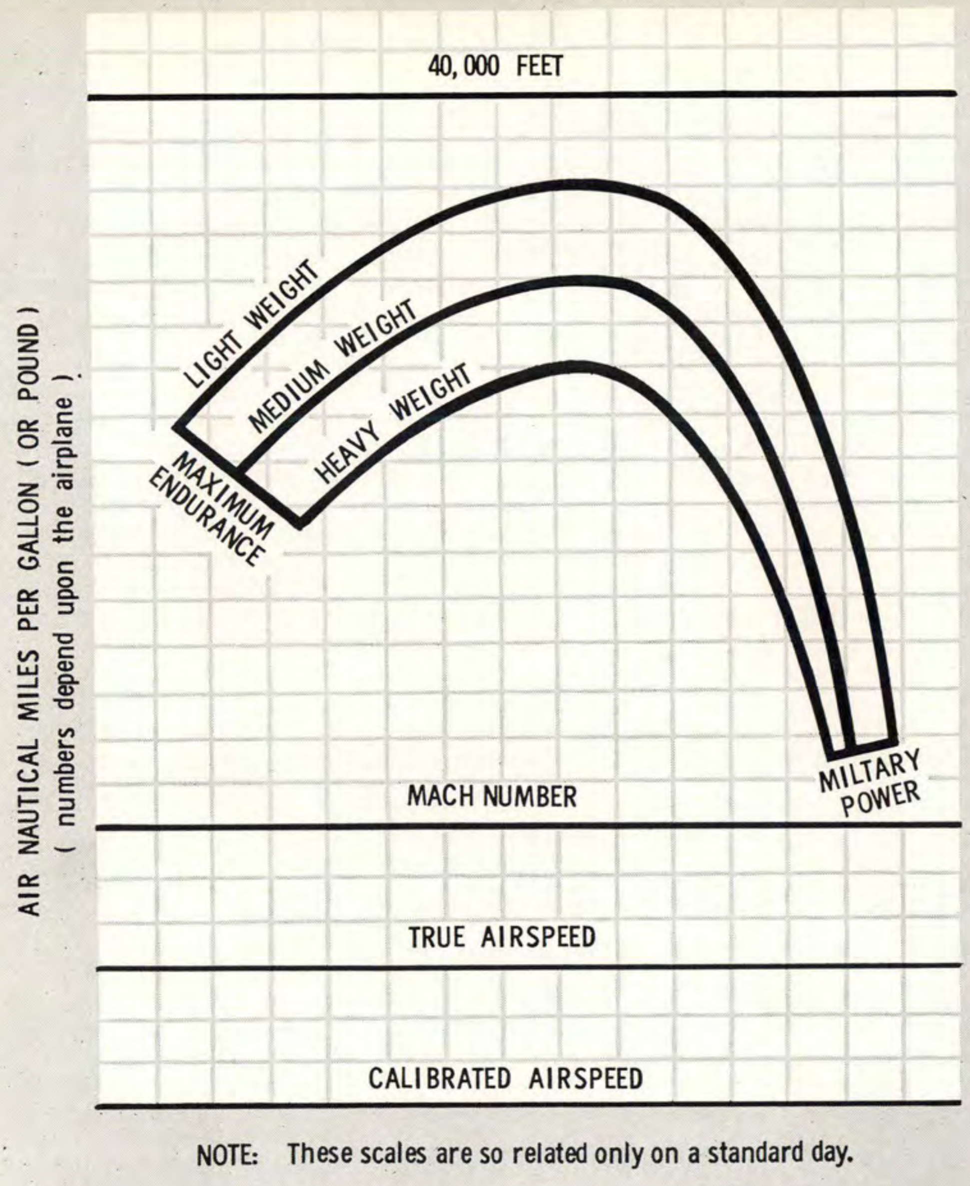
Today, however, the temperature is colder than standard, so by flying the true airspeed indicator you are not at the optimum cruise speed. You are going too fast for efficient cruising. This incorrect airspeed causes you to have too high a power setting which, in turn, increased your fuel consumption unnecessarily.

But why does an error of a few knots in cruise speed have such a large difference in the fuel consumption? This phenomena can be understood by realizing how the drag of an airplane changes with airspeed. At the best

When the fuel gages read lower than you figured during preflight, don't criticize the data in the Pilot's Handbook. Study and learn to use it correctly.

knot error

Captain Robert H. Jacobson, Instructor, USAF Experimental Flight Test Pilot School.



Obtain from curves for your aircraft calibrated airspeed or Mach number for recommended cruise and use power necessary to fly it.

glide speed the drag of an airplane is at the minimum. The recommended cruise speed is higher than the speed for minimum drag so, in the vicinity of the recommended cruise speed, the drag increases as the speed increases.

But, if the speed reaches the transonic region the drag suddenly starts to increase at a much greater rate. The transonic speeds are first reached at Mach numbers from 0.8 to 0.9 or higher, dependent on the particular airplane design.

Most of the present Air Force airplanes cruise at speeds just slightly below the transonic speeds, especially at high altitudes. So a slight increase in speed above that recommended for cruise will result in a rapid increase in drag. This drag rise occurs at a given Mach number and *not* at a certain true airspeed.

"But why shouldn't a true airspeed indicator be used for cruising?" We're getting to that, but first we must define Mach number. Mach number is the true airspeed divided by the speed of sound and the speed of sound depends *only* on the temperature of the air. So we can conclude that the Mach number depends on the true airspeed and the temperature of the air.

Or, if we look at it another way, we can hold a constant true airspeed and obtain different Mach numbers if the temperature of the air is not constant. We can prove this last statement by using the E-11 Computer.

Assume that you are flying at a true airspeed of 480 knots on two different days. On the first day the air temperature is −55°C., and on the second day it is −70°C. Set the hairline of the E-11 on a true airspeed of 480 knots. (Note that we will have a temperature rise of 24°C. which we must account for in using the Computer.) Our temperature settings in the Computer must be −31°C. (−55°C. +24°C.) and −46°C. (−70°C. +24°C.).

Turn the inside disk until these temperatures are under the hairline. We read Mach numbers of 0.83 and 0.865 for the −55°C. and −70°C. days, respectively. This change in Mach number may be large enough to produce a large increase in your airplane's drag.

So this was your mistake. You attempted to hold the recommended cruise true airspeed (which applies only for a standard day) on a cold day flight. This true airspeed gave such a high Mach number that you were flying in the region of the rapid drag rise. This high drag required a high engine thrust which in turn resulted in excessive fuel consumption.

Air temperature is rarely standard. If the cruise curves are good only for standard day conditions, are they practically useless to the pilot? It is correct that the true airspeed data does not apply for non-standard temperatures. In addition, the power setting data will be incorrect for other than standard temperatures.

But the most valuable information to obtain from the curves applies to non-standard as well as standard days. The specific range data (or miles per pound data) will be reasonably accurate and the recommended calibrated airspeed and Mach number for cruise apply directly for all temperatures.

So you should have obtained from the published cruise curves the calibrated airspeed or Mach number for recommended cruise and used the power necessary to fly at this speed. Then you could have been sure you would not fly in the region of the high drag rise. For all practical purposes you can consider calibrated airspeed to be the same as indicated airspeed.

But in case your airplane has an excessive airspeed position correction you should use this correction to determine the indicated airspeed to give the desired calibrated airspeed. The airspeed position corrections for your airplane are also given in the appendix to the handbook.

You have to make a choice of which indicator to cruise by—either the airspeed indicator or the Machmeter. Use the one which can be read with the greatest accuracy. When you fly by the indicated airspeed at a given altitude you will be at a certain Mach number regardless of the temperature of the air. Therefore, there will be no danger of reaching too high a Mach number and encountering the high drags associated with transonic speeds.

Using technically correct terms, Mach number is determined in flight from calibrated airspeed and pressure altitude and is independent of temperature. However, it is to be remembered that true airspeed varies with temperature at a constant calibrated airspeed and pressure altitude.

The point to remember is this: Don't criticize the data in the Pilot's Handbook. The thing to do is study the much maligned handbook. Learn to use it correctly. ▲

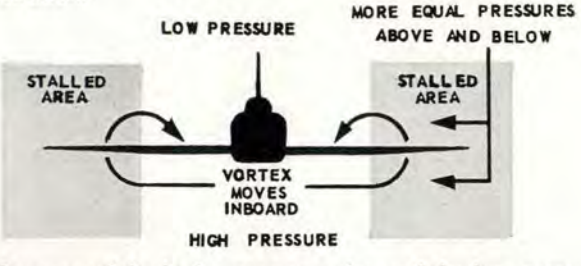
★ ★ ★ ★ ★ ★

THE FINE POINTS OF PITCH UP

Capt. Harold J. Eberle, D/FSR Liaison Officer, Edwards AFB, California

After reviewing my notes made while we were discussing the pitch-up problems (FLYING SAFETY, October 1958), I find that I overlooked one of the factors which causes the '101 to pitch up. We discussed the forward movement of the center of pressure as the tip of the wing stalls. This center of pressure is the resultant of summing up all the lift forces which are remaining. It moves forward since the tips stall out first and, due to the sweep, the remaining forces come from a more forward portion of the wing. This causes a nose-up moment.

Another factor can best be explained by the following illustration:



Because of the high pressure under and the low pressure over the wing, the air attempts to equalize the pressure and follows the arrow around the tips. This causes the familiar wingtip vortex and influences the downwash pattern. When portions of the wing reaches a stalled condition, all of the available lift must come from the remaining unstalled area. Due to the sweep of the wings, the tips tend to stall first and the inboard part must carry the load. This puts the inboard section at a higher lift coefficient and angle of attack. Downwash is a function of the lift coefficient and is increased. Actually the net result is that the tip vortex moves inboard.

Another way of looking at this is to realize that when the tips stall, the airflow is broken down over this area. This destroys the low pressure area on the upper surface and with it the vortex causing differential pressure also is lost. The vortex no longer hangs on to the wingtip but moves inboard. When it moves in far enough so the tail gets in its wake, then the nose-up moment is produced.

The F-101, therefore, pitches up because:

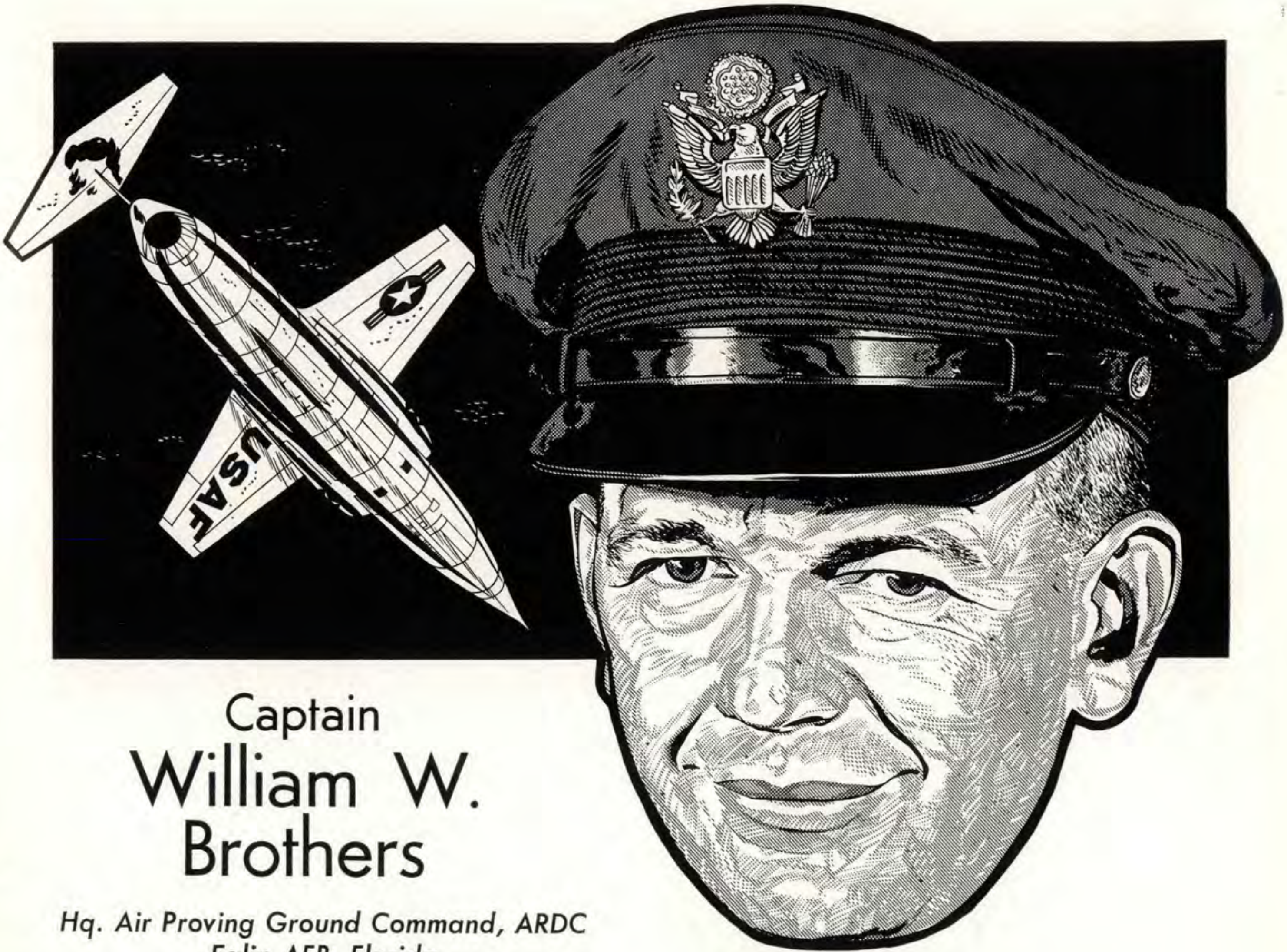
- *The center of pressure moves forward on the swept wings as the tip stall. This gives nose-up moments.*

- *The downwash on the tail is increased since the lift coefficient of that portion of the wing in front of the tail is increased. This gives a nose-up moment.*

- *The tip vortex in effect moves inboard as the pressure differential from top to bottom of the outer wing is reduced. The vortex strength is a function of this differential pressure. This movement of the vortex strikes the tail and causes a nose-up moment.*

The F-104 problem is slightly different. Here, the short wing span induces a very strong tip vortex. The aspect ratio very strongly influences the vortex system. When the high tail is lowered enough so that it enters this strong vortex system, a strong nose-up moment is produced.

In both airplanes, these sudden nose-up moments are so strong that the pilot cannot prevent the airplane from pitching up out of control if he allows it to progress to a certain point. This condition can be reached in unaccelerated (1G) or accelerated (maneuvering) flight so it is not dependent on airspeed. It is rather more nearly a function of the angle of attack. For this reason the inhibitors usually read both angle of attack and pitch rate in order to prevent the pilot from getting close to this critical area of flight. ▲



Captain William W. Brothers

Hq. Air Proving Ground Command, ARDC
Eglin AFB, Florida

★ WELL DONE ★

Early this year Captain Brothers was assigned to a flight test mission in the F-104 at Eglin Air Force Base. His mission was to evaluate the debris ejector used in conjunction with the M-61 gun installed in the aircraft. His takeoff, climb and acceleration to desired airspeed after reaching test altitude were all uneventful.

In preparation for firing, full afterburner was used and the airstart ignition was actuated as a precaution against flameout. Captain Brothers put the '104 into a left turn and sustained 4G as firing of the gun was begun. As the gun was firing, he saw that the G meter was fluctuating considerably. The gun stopped firing before the trigger was released and simultaneously a severe vibration began. The cockpit filled with debris which appeared to come from the vicinity of the pilot's elbows. The combination of debris and vibration made it all but impossible for Captain Brothers to read the instruments.

He interpreted the vibration to be possible engine trouble and stop-cocked the throttle. Vibration persisted and as there was no indication of engine fire he restarted the engine. Power was increased and the vibration became more intense. Again, Captain Brothers stop-cocked the throttle and again could not note any lessening of vibration. A second re-start was made and power was increased to 80 per cent.

By this time there was less debris in the cockpit and Captain Brothers was able to see daylight through the floor of the aircraft below his left foot. The escape hatch had blown from the bottom of the F-104. Speed brakes were extended and a letdown at 170 knots was made to 15,000 feet on 100 per cent oxygen. Severe vibration continued and the Captain's helmet was oscillating on his head to such an extent that double vision resulted. Communication with Eglin tower was barely possible because of the high noise level within the cockpit. The F-104 was landed without further damage in spite of the enormous difficulties encountered. An invaluable aircraft with all its test instrumentation was saved.

Well Done, Captain William W. Brothers.

• TIPS ON T-BIRDS •

The T-33 has been in the Air Force inventory for ten years. It can be one of the safest planes we fly. Unfortunately, the accident rate in this fine craft remains much too high. Familiarity has led to complacency.

Some of you will wonder why we should continue to devote special attention to one type of aircraft, using practically the same title for articles month after month. It is simply that we are convinced that accidents can be prevented if everybody gets busy and really tries. With the "T-Bird," the facts are these: There are nearly 3000 T-33 aircraft in the USAF inventory. They are used at almost every base in the ZI and abroad. The T-Bird is flown by more pilots than any other single aircraft we possess. It has been the logical successor in the jet age to the T-6 of the recip days.

Rightfully, the T-33 should be one of the safest planes we have. It has been around long enough to have most of its "bugs" eliminated. Those that are left should be well known to all who fly it. Unfortunately, the accident rate in this airplane has been much too high. In 1957, the rate still held at 19, a reduction of only nine points from 1954. In 1954, 92 persons lost their lives in the T-33. Already this year, 41 fatalities have been recorded, although the rate has dropped to an encouraging 12.3 for the first six months.

From the above statistics you can see that there is a big job left to do in preventing accidents in the "old faithful" T-Bird. Pilot error, particularly in the landing phase, continues to be the big killer of T-Birds and sometimes pilots too. You can help to eliminate this prime danger area. Let us hear from you so that we can pass along your "Tips-on-T-Birds."

Major Wallace W. Dawson, Research & Analysis Division, D/FSR.

Labor Day is traditionally the end of summer— just as sure as the world is round. Oh sure, you might still get a sunburn if you aren't careful, but after Labor Day's come and gone, if you aren't thinking about turkeys and Christmas presents, you're likely to get caught short.

With this passing of "the good old summertime," we, in the flying business, trade one set of problems for another. There won't be as many thunderbumpers to dodge, and you won't have to figure your takeoff roll from Lowry *quite* so close, but new problems do rear their ugly little heads.

For instance, the jet streams move south and get stronger—which is real fine if you could always go east. Winter means cold weather which means the "ready solidification of certain liquids when temperatures are at or below so and so." Ice to the average jet jock is not too much of a hazard, especially the type that tends to cling to the structures of the aircraft. Climbing will usually take care of this situation and if there's one thing a jet will do better than most, it's climb. If the hazard is in between you and terra firma and you have to go down through it, go down fast and there's not too much a problem that way either.

There is a kind of icing though that we know has caused trouble and may have caused a lot more trouble than we knew. That's fuel system icing. For some unknown reason, this seems to be a particular hazard in the T-33 type bird and since we operate nearly 3000 of them, this article may be appropriate.

To start off, JP-4 has an affinity for water. This means that the two will get together whenever possible. The first reaction to this is that water doesn't belong in the fuel system anyway so all we have to do is eliminate the water and our troubles are over. True—and right now—some of the best brains in the country are working on this very problem. Eventually, it will be whipped. But for the time being it is with us and something we just have to live with.

So let's say (and this is true) that as of this date, it is impossible to eliminate all of the water from JP-4. Water being water, it will freeze when its temperature goes to freezing or below. This is practically every flight in the T-Bird because even in the summertime the freezing level will be below your cruising altitude if you're going any place at all.

This means then that on practically every flight the ingredients for fuel system icing are present—water and low temperatures. Naturally, this situation is aggravated in the winter time, and this is the time whereof we desire to speak.

From past experience, we know that the de-ice warning system in the T-33A aircraft cannot always be depended upon. Ice may form downstream of the filter where the pressure differential switch has already been passed. You might think that this puts us behind the eight ball on ice formation warning, but this isn't true. Ice in the engine fuel system tends to disrupt the normal fuel flow which may result in fuel starvation and flameout if not corrected in time. Ice forming in the low pressure fuel filter will normally be indicated by illumination of the fuel de-ice warning light; but ice forming downstream of this filter must be detected in another way.

Since ice formation in the fuel system restricts fuel flow, this condition is easily detectable even though the fuel de-ice warning light does not illuminate. If the RPM fluctuates, or you are unable to obtain a higher RPM than you have been using, or you experience apparent loss of throttle control, look out—the ice man may have been there. If one or more of these things do happen to you, stay loose; all is not lost, yet.

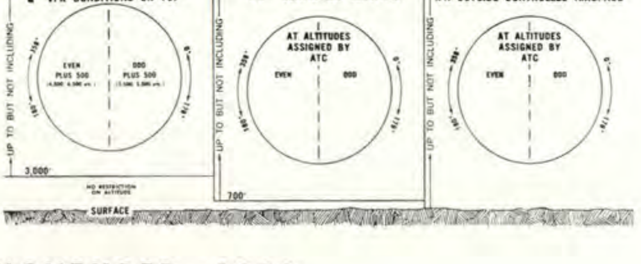
True, there are other things that can happen to your airplane that may give you the same indication, but in any event, if you stick by the following procedures, you can't lose and you may gain. If the engine instruments behave like we mentioned, and the trouble actually is ice, it can be removed before you reach the panic stage.

If ice formation is evident or *even suspected*, hold the fuel filter de-ice switch ON until the light goes out, RPM stabilizes or desired RPM can be attained. In fact, we can even go one better on this. At extreme flight altitudes where temperatures are very low or during cold weather operation when below freezing temperatures have existed for some time during the flight, give her a shot of alcohol, 15 seconds for each 30 minutes of flight.

If you're actually flying in the clouds anytime, a 15-second shot can't hurt anything. This is especially true before starting penetration when throttle setting is low and fuel flow slow.

That "before starting" bit brings up another thought without which none of this will do you any good. The reason that it has been left out so far is that it is entirely elementary to all sorts of winter flying—or into areas that are affected as in "cold weather." This one is simply the matter of knowing that you have the proper equipment for the flight you anticipate. It does little good to tell you how to get out of icing conditions unless it is first assumed that you've taken the proper precautions to make sure that you have plenty of fluid—that the system has not been disconnected—that it works despite the Form 781. These are all your responsibilities before you accept the bird for your trip.

If, and only if, you have taken these few precautions we might wrap it up in a neat little package this way. If the light comes on, use alcohol. If RPM fluctuates, you can't increase RPM or it seems like you have lost throttle control, us alcohol. If you're real high where it's real cold, use alcohol. If you're in the soup or see it coming, use alcohol. If it's cold from the ground up, use alcohol. If there's even a thought in your mind about fuel system ice forming, use alcohol. What have you got to lose? ▲



PILOTS NOTE....

The October 1958 issue of FLYING SAFETY included a chart (Page 4) designed to portray proper altitudes to be flown, depending on direction to be flown. Although received on good authority, and published with the best of intentions, the chart was wrong. Wrong, in that it showed "Heading" to be flown, rather than "Course," as required by AFR 60-16.

This same error exists on many locally reproduced charts similar to the one published here. Check yours to see that it shows "Course." The change is shown in a revision to the Flight Planning Document.

SPLASH DEPARTMENT . . . accidents resulti

During the first six months of 1958 the USAF has experienced 12 inadvertent gear-up landing major accidents as the result of pilots failing to activate or check landing gear controls or accidentally activating gear controls prior to touchdown or during landing roll.

A review of accident reports pertaining to these occurrences indicates that in the majority of the instances the pilot stated over the radio that the landing gear was down and locked. It is perhaps significant that only two accidents occurred at night and, regardless of total time which ranged from 387 to over 8000 hours, only three pilots had less than 130 hours in the aircraft model. This indicates that perhaps the lack of familiarity or experience is not an underlying cause. Although none of the aircraft received greater than substantial damage and no pilot or crewmember injuries resulted, the dollar loss to the aircraft amounted to over one million.

Gear-up landing accidents exemplify the type of pilot factor preventable accident throughout the Air Force. Past corrective action taken by operational units and bases to prevent recurrence was in general limited to "bring the accident to the attention of all pilots." Recurrence of inadvertent gear-up landings indicates this type of corrective action has not produced the desired results. Only one pilot involved in the accidents included in the study was required to complete a recheck in the aircraft because of lack of knowledge.

Previous studies by the Directorate of Flight Safety Research indicate that distraction of the pilot or interruption of landing procedures are an underlying cause of many inadvertent gear-up landings.

The Navy, experiencing similar problems, has adopted a requirement that on a go-around, the pilot perform a complete re-entry into the pattern and completely re-initiate all landing procedures. This is to reduce accidents due to "psychological set." That is, the pilot, having completed an activity, namely the extension of the gear on the first approach, has a feeling of completeness, and hence, fails to re-extend the gear on the second approach when the sequence of landing activity is different than that normally accomplished.

In another study of 168 inadvertent gear-up landings, it was brought out that 30 of the 168 had been preceded by the customary, automatic, habitual statement, "Turning base, gear down and locked." ▲

★ ★ ★

The F-100C landed after a test flight mission following a periodic inspection and IRAN. A normal pattern and landing was accomplished, with the touchdown about 800 feet down the runway at 160 knots. The pilot deployed the drag chute which immediately separated from the aircraft. When the F-100 had slowed to 120 knots, the pilot applied brakes. They were ineffective and the tower was advised. The aircraft continued off the end of the runway, across a 250-foot blast pad, on over 1100 feet of compacted surface and an additional 1730 feet onto a graded sandy surface. It came to rest about 3084 feet from the runway after collapsing the nose gear.

Investigation revealed that the primary cause of the accident was maintenance error in that the drag chute deployment mechanism was improperly rigged and the correct procedures had not been followed by maintenance personnel after the anti-skid detectors had been removed from the aircraft. The cannon plug had not been disconnected from the anti-skid control box when the system was inoperative or incomplete—as prescribed by the T. O.

★ ★ ★

While flying a B-57E on a local tow target mission the pilot felt erratic rudder control pressures. He switched to manual rudder and checked the hydraulic pressure gage. Both the main system gage and brake pressure gage registered zero. After two approaches to check airspeeds and attitudes the pilot set up a landing pattern, opened the "star valve" and used the hand pump in an effort to build up brake pressure.

Approximately half way down the runway (5000 feet) the engines were stop-cocked and the canopy jettisoned since no braking action was available. The B-57 ran off the end of the runway at a speed of 85 knots and struck a mound of sand, causing the nose gear to collapse. The aircraft slid another 1500 feet on its nose section and main gear.

Maintenance error was the primary cause of this accident. The elbow fitting to No. 2 engine hydraulic pump was incorrectly installed. The brake failure was caused by the pilot's inadvertently actuating the pedals during the rudder control difficulty. He thus bled off the emergency brake accumulater pressure.

★ ★ ★

The B-52D was on a night tactical mission with seven crewmembers aboard. While on a GPI navigation bomb run the pilot's flight indicator tumbled; the N-1 compass rotated approximately 90 degrees to the left; the two drop tank lights illuminated; the battery-not-charging lights came on; the radar and ECM normal interphone systems failed and the gear indicators went to an intermediate position. All four alternators were operating normally but the DC forward transformer rectifier units indicated no DC output. This pilot had troubles!

Home base weather was deteriorating rapidly so the pilot diverted to Dow AFB, Maine, descended to 10,000 feet and depressurized so that the engineer could go forward. Inspection revealed that all AC fuses were blown and efforts to correct the difficulty failed. Westover AFB was now selected as the most suitable alternate because of the 11,600-foot runway available. At the start of the initial penetration, the gear handle was placed in the down position, but the gear failed to extend. The B-52 touched

ng from faulty maintenance or inspection

down 1600 feet from the approach end, gear and flaps up. It slid off the runway at the 7000-foot mark, and the crew evacuated the aircraft through emergency exits without injury.

The immediate cause of the accident was failure of four forward transformer rectifier power units. This in turn led to rapid discharge of the forward battery in flight. Maintenance personnel had not completely corrected a deficiency on the transformer rectifier noted on a previous flight.

★ ★ ★

A crew chief completed the preflight inspection of his C-131 before sunrise. The inspection included draining the fuel tank sumps and running up the engines. Everything appeared to be normal and the pilot accepted the aircraft then taxied out to the runway. The pilot's runup was satisfactory and after the crew briefing, the '131 was cleared for takeoff. The takeoff roll was normal until flap retraction was started at an altitude of 100 feet and an airspeed of 122 knots.

At this time the BMEP gages on No. 1 and No. 2 engines were seen to indicate low. The auto-feather pump light also came on. The pilot landed the aircraft straight ahead on the concrete runway and the crew evacuated the plane, without injury. Extensive damage was done to the propellers and airframe from the hard touchdown.

It was determined, during the investigation, that the nearly simultaneous loss of both engines resulted from slugs of water entering the induction system through the fuel feed lines from the tank sumps. The water was picked up when the plane was rotated about its longitudinal axis for takeoff and climb. The water was in the sumps because of improper draining of the fuel system during previous preflight inspections. The engineer stated that he had checked the fuel sumps by draining a quantity of fluid into his *gloved* hand.

★ ★ ★

During a bombing mission in his F-84F the pilot entered his first dive bomb pattern at 0950 hours and completed one hot pass, pulling 6G in the recovery. He entered a second dive bomb pattern, released the bomb at 450K and initiated his pullout. As Gs were applied he felt a landing gear extend. He throttled back to idle, extended speed brakes and eased the nose to the horizon, pulling a maximum of 3G. The gear handle was then checked and found to be locked in the UP position. Another pilot noted the right gear was extended outboard, well beyond the normal limits. The pilot proceeded to a base with an extra wide runway for landing as it seemed almost certain that the right gear would fold at touchdown. As it turned out, the plane was landed uneventfully and without further damage.

Prior to this incident the crew chief and post dock chief had corrected an obvious discrepancy in the nose gear uplock, and superficially examined the remainder of the gear system. During the periodic inspection, an individual with very limited experience on the F-84F had performed the gear inspection. This airplane had also had a history of unsafe gear indications. Investigation revealed that the right main gear uplocks were out of adjustment at the time of a previous pilot write-up. A superficial inspection had been made then and as one left gear microswitch was found out of adjustment, this was assumed to be the only discrepancy.

★ ★ ★

The mission of a C-119G involved the airlift of U. S. Army personnel and cargo. Fifteen crewmembers and passengers were aboard. The aircraft was being taxied from its parking apron for departure and the aircraft commander, seated in the right seat, lifted the cover of the emergency gear retraction switch. As he lifted the cover to inspect for safety wire, the nose gear collapsed.

Inspection of the safety wire on the cover revealed that safety wire was looped around the emergency gear retraction switch. Improper safetying of the cover resulted in movement of the switch when the cover was raised.

Prior to the accident, the aircraft was traveling at a speed of about seven miles per hour. The nose section was extensively damaged.

The Role of AMC

Maj. Gen. William T. Hudnell, USAF, Director, Maintenance Engineering, Hq. AMC.

The Air Materiel Command—perhaps better known as AMC—is one of the eighteen major commands of the Air Force and has its headquarters at Wright-Patterson Air Force Base, Dayton, Ohio. It is the hub of world-wide procurement, supply and maintenance activities of the Air Force.

The Directorate of Maintenance Engineering is the focal point of the Command's maintenance operation. Its field organizations, the Air Materiel Areas and Air Force Depots, have similar organizational structures. In 1957, AMC's maintenance personnel in continental United States totaled approximately 68,000 people.

Maintenance engineering services in support of the Air Force fall into two general categories: *Technical* and *Production* support.

Technical support consists of advice on how to maintain equipment, as well as programming for modernization and maintenance engineering logistic support of all Air Force and Mutual Assistance Program equipment.

On the Production side, the actual overhaul of equipment, AMC annually processes about 35 million items through its depot maintenance shops. This includes the modernization and overhaul of about 12,000 aircraft and 35,000 engines. This support does not include the maintenance services furnished by maintenance contracts.

Two aspects of Air Materiel Command's maintenance operation are of particular interest to flight safety. One involves the way that material deficiencies are reported

and processed. The other concerns the handling of accident reports and is known as the Flight Safety-Materiel Evaluation Program.

Pursuant to its constant aim of speeding up correction of deficiencies on aircraft and equipment, during 1958 AMC refined its system of reporting and processing these deficiencies.

Working out the system for collecting data on aircraft and related equipment deficiencies was a joint responsibility shared by Headquarters USAF and AMC. At AMC then, the responsibility became that of the Engineering Systems Division of the Directorate of Maintenance Engineering.

Under this organization's guidance, three publications have taken form and put to use during this year. They are: Air Force Manual 66-1, Organizational and Field Maintenance, 1 July 1958; Technical Order 00-20A-1, 1 July 1958; Aircraft Inspection System, Preventive Maintenance Policies and Procedures, and Records Administration, and Technical Order 00-35D-54, 15 August 1958, Technical Manual, Materiel Deficiency Reporting, Aircraft and Related Equipment. These publications outline the procedures which form the connecting link between the man who flies the aircraft and this Command.

Air Force Manual 66-1 spells out the system for collecting maintenance data at base level. This system provides maintenance management with information on what production jobs were performed by the manpower charged to direct labor in each organization, unit, shop or work center. In addition to what was done, the system provides data as to how many direct manhours were expended, why each repair was required, when the malfunction was discovered and who accomplished the work.

All maintenance jobs are recorded in such a manner that comprehensive data are available at base level. Failure rates versus airframe and engine time must be analyzed. Malfunctions must be related to inspection period. Reliability expectancies must be analyzed for systems and components. Frequency and volume of malfunctions must be related to the period during which they're discovered.

Key documents of the base level data collection system are AF Tech Order Form 781 and the 26 series. The Form 781 is filled out by the pilot and the 26 series Forms are completed by maintenance personnel. From these documents, necessary work on the aircraft or equipment is scheduled and accomplished. Of further significance, however, is the way that these documents and the data collection system outlined in AFM 66-1, mesh with the Unsatisfactory Report (UR) system.

Unsatisfactory Reports have long been a part of the Air Force scene. The quantity of these reports has constituted a problem in the past, and quality of reporting has caused almost as much trouble. By basing these reports on data collected at base level under AFM 66-1, AMC believes that both of these problem areas will be eliminated.

The focal point at base level is Quality Control, which also is responsible for the UR control function. Specifically, the UR control function is to:

From engine container to final inspection keynote of AMC is quality. Employing thousands in maintenance and repair shops throughout the world, Air Materiel Command provides service to AF aircraft.

Engine technicians watch instrumentation as engine is tested . . .

- Process all URs as required by T.O. 00-35D-54.
- Establish and maintain an effective program to insure the proper and timely submission of URs and maintain records necessary to determine UR trends.
- Keep the Chief of Maintenance and Maintenance Control Supervisor advised of unsatisfactory trends and conditions affecting safety of flight and operational capabilities.
- Review and disseminate data pertaining to action taken on URs.

Data collected at base level is then analyzed carefully, and reports traceable to base procedures or lack of technical ability are screened out. This cuts down on the volume of reports going out to Headquarters Air Materiel Command, and to prime weapon system and commodity Air Materiel Areas.

When conditions indicate that an Unsatisfactory Report is necessary, data provided by the system under AFM 66-1 are used to the fullest extent to give the required background information to the AMC activity which will receive the report.

Emergency URs are used to describe safety conditions, the known or suspected and uncorrected existence of which could result in fatal or serious injury to personnel, destruction of valuable property, or have serious effect on the safety of the nation.

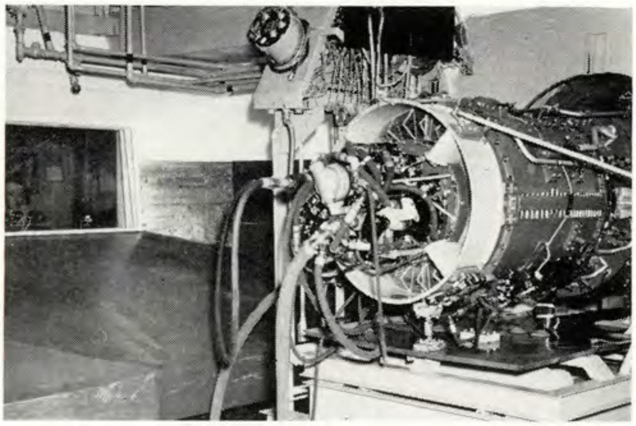
Other URs ("Urgent Action" or "Routine", depending on the nature of the condition) describe potentially hazardous conditions which could result in serious injury to personnel or damage of valuable property and reduce combat effectiveness. Continuous usage of unsatisfactory item of equipment may have a negative effect on operational efficiency, reduce tactical or tactical-support utility or reduce operational life of the equipment.

What happens when conditions warrant an emergency UR?

First, the UR is handled with all speed. It is reported immediately, along with supporting data, to the prime weapon system Air Materiel Area responsible for the aircraft or equipment. Such report is made by telephone, multiple address teletype, radio or airmail message direct. The appropriate areas are listed in T.O. 00-25-115. At the same time that this report is made, the major command headquarters of the reporting activity is also notified of the hazardous condition.

Information copies of Emergency URs are sent to the prime commodity Air Materiel Area or Air Force Depot, the Office of the Inspector General, the Maintenance

. . . and at the same time watch the engine itself for signs of trouble.



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ABOUT THE AUTHOR

General Hudnell was appointed Director of Maintenance Engineering at Hqs AMC in August of this year. His first major assignment in the materiel field came May, 1942, when he was named Chief of Staff for Materiel for the First Fighter Command at Mitchell Field, New York.

His first tour in the Southwest Pacific Area began in July 1943 and ended in August 1945. During this period he served in several major assignments.

In August 1945 upon his return to the ZI he was assigned to the Army Air Forces Headquarters where he served as Chief of the Materiel Branch, Office of the Assistant Chief of Air Staff for Operations.

General Hudnell graduated from the Air War College at Maxwell in July 1950 and was assigned to Hq USAF in the Directorate of Logistics Plans.

In July 1954 he returned to PACAF (then FEAF) as Vice Commander of the Far East Air Logistics Force in Japan, and in November 1955 he assumed command of the Air Materiel Force, Pacific Area, serving until his return to the ZI.

The real test comes when planes are prepared for final test flight and the final touches are put on replacement engines to be shipped to you.

Directorate of Headquarters AMC, and to the applicable center of Air Research and Development Command.

What happens next to an emergency UR?

Of course all resources of this Command and the contractor are put to work to correct the hazardous condition. This work begins immediately. Meanwhile, the prime AMA or AF Depot is required to notify the submitting activity within 24 hours of action to be taken.

The preceding paragraphs have concerned handling of emergency URs on aircraft and related equipment. A special procedure also exists for reporting electronic equipment failures, and for special weapons. Additional procedures also are included for engines, which figure in a high percentage of aircraft malfunctions.

When an aircraft accident or mishap occurs, AMC has certain further responsibilities when materiel deficiencies are involved. These are outlined in AMCM 66-2, Part 7, The Flight Safety-Materiel Evaluation Program.

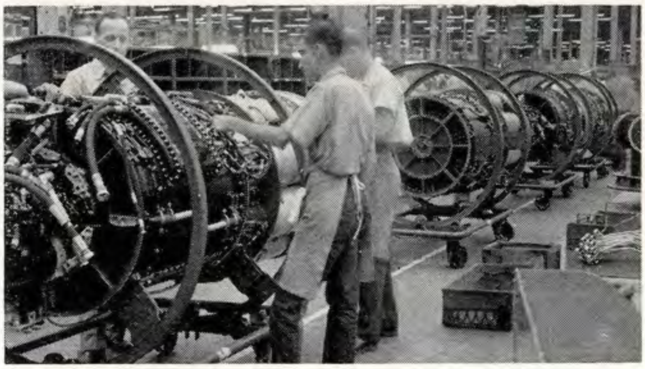
Aircraft misphaps are categorized in order of their severity, as aircraft incidents, minor or major accidents. It is AMC's responsibility to correct materiel deficiencies causing these mishaps expeditiously.

Prime Air Materiel Areas are required to establish Aircraft Accident Investigating Boards for all first line and new production aircraft. These boards are made up of experts in various categories, such as structures, power plant or electrical systems. These members are on call at all times to assist or participate in any aircraft accident investigation concerning their prime equipment.

When an accident occurs, the using activity convenes an investigating board to determine the cause. They may solicit technical help, if needed at the scene of the accident.

The Air Materiel Areas record all accident data and compile a quarterly evaluation of materiel deficiencies to depict trends and indicate corrective action.

Also in existence at the Air Materiel Areas and AF Depots is a group which operates on a continuing basis. This is known as the Flight Safety-Materiel Deficiency Task Group. The purpose of these groups is to provide a continuing program to maintain management of AMC's logistical support of the USAF Flight Safety Program. The main objective is to expedite corrective action on flight safety-materiel deficiencies. AMA groups meet weekly and bi-weekly, depot groups meet once a month. Special meetings are called when necessary.



Headquarters, Air Materiel Command has administrative responsibilities concerning all of these groups. However, since decentralization, the bulk of the operation has been at the AMA level. The headquarters group provides guidance and resolves general problems involving several areas or special problems which cannot be solved locally. The responsibility for this function rests in the Aircraft and Missiles Division of the Maintenance Directorate.

Air Materiel Command's ultimate goal maintenance-wise is to provide operational commands with weapons so airworthy that only improper operation or adverse weather conditions can cause a mishap. Maintenance personnel throughout the Command are dedicated in the pursuit of this objective. ▲

The Search in

Wayne Pryor, Editor, "Hangar Flying"
Lockheed Aircraft Corp., Burbank, Calif.

Flying today is more than ever a teamwork proposition, pilot and crew chief. A good crew chief is worth two or three parachutes. Use him.

Time was when any pilot worth his salt could go out, preflight the airplane and almost always find half-a-dozen or so discrepancies just to show the crew chief he was keeping an eye on the hardware. And time was when old-time crew chiefs would leave a piece of safety wire or something dangling just to give his Second John something to find.

We feel this sort of jazz went out with the piston-engine fighter. It is long gone with the F-104. This airplane flies in speed regimes where a "little something wrong" is more than an annoyance. It can well be lethal. Your crew chief needs to be such that you can expect to and should find a clean airplane when you arrive at the flight line.

If you can find something seriously wrong—say a flat strut—you don't want to chew out the crew chief. You want a new crew chief.

We're of the opinion that a good crew chief is worth two or three parachutes. Flying the F-104 is a teamwork proposition and you work with —not in spite of—your teammate, the crew chief. For example, on the T-Bird you may recall that to check the oil you stretch down into the bowels of the airplane, unscrew the cap and take a look. This is not part of the preflight on an F-104. You can't check the oil. You must take the crew chief's word that he filled the reservoir until oil came out of the vent plug hole, as prescribed, and then he buttoned up the airplane. More dangerous? Nope. It's just an example of how (in modern airplanes) more reliance is placed on the ground crews for maintenance.

Chew the Fat. One thing for sure, don't be in such a hurry on your walk-around that you don't stop to talk to the crew chief. Taking a minute to chew the fat with him may well be the most valuable part of your preflight. This is especially true if you're new to the airplane, or if the airplane is not the one you normally fly.

Every airplane has its own individual characteristics. The crew chief finds them out very quickly and will tell you, if you'll ask. And don't be too quick to jump on the crew chief if you find something that looks a little different. Ask his opinions; there may be a good reason for the particular situation.

So much for the sermon. What we're really getting around to saying is that preflighting an F-104 is pretty much a cinch. There's not much for you to do. The crew chief takes care of most of the details.

We Look Extra Close. You'll find the recommended procedure for a walk-around under "exterior inspection" in the Dash One, but there are a few items that we take an extra close look at. Here's one that you may want to pay close attention to until everyone is so well-briefed on it, that it becomes part of the squadron SOP. In the center of the hydraulic panel that swings down out of the belly of the airplane there is a gray metal box about the size of two king-size cigarettes side by side. It has a handle on the top. Hooked around the handle is a long aluminum arm that goes up to the belly sill.

This box is the system selector valve for your hydraulic system. It is the only place in the airplane where your two separate systems meet. When the handle is pushed forward, toward the nose of the airplane, it is on the number two system. The handle should be safety-wired in this position. (To the rear is the number one, emergency system. Mid-position is both.)

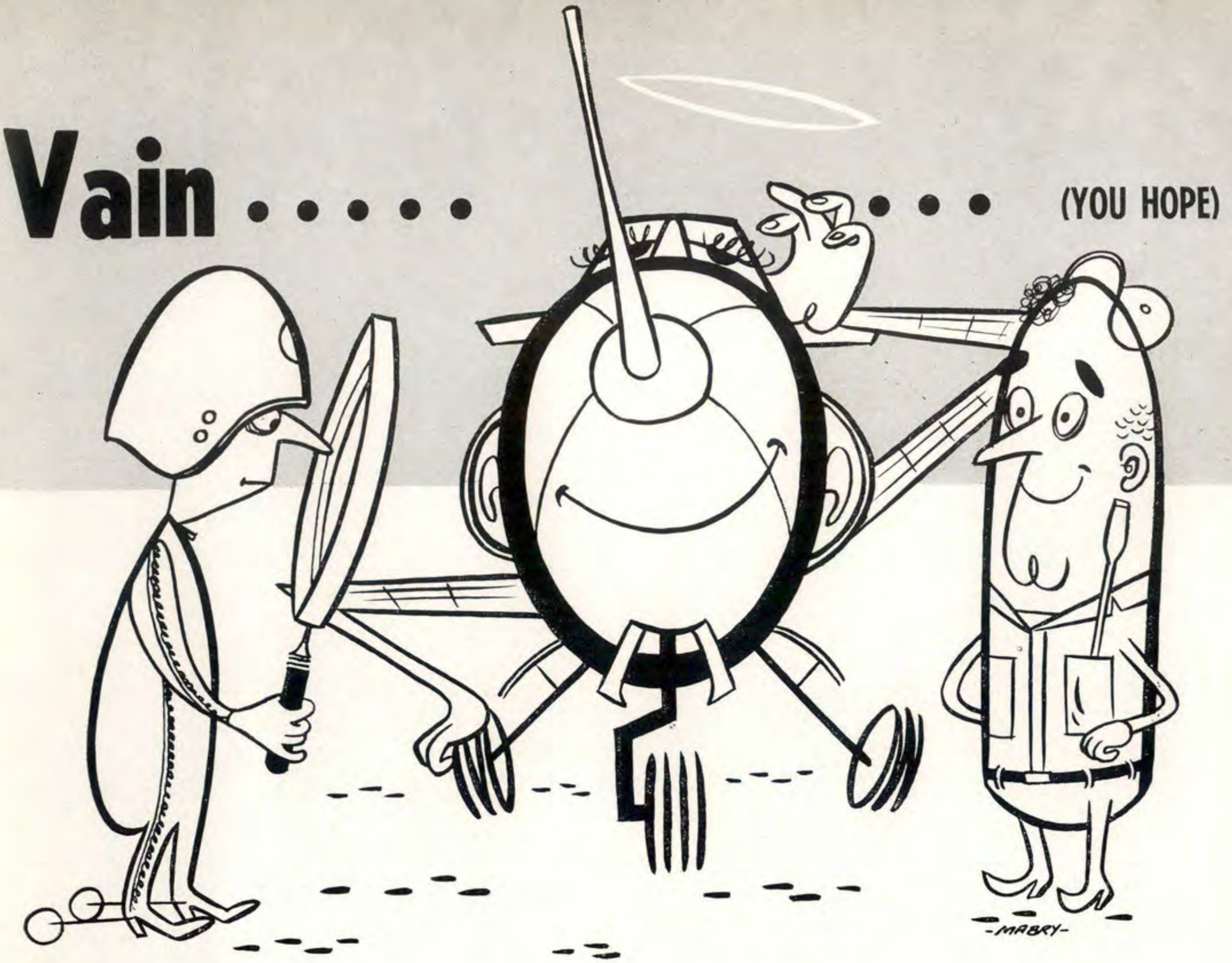
A "fool proofer" Is Added. When the crew chief works on the hydraulic system, he normally breaks the safety and puts the handle in the middle position so he can check both systems at once. Should you take off with the handle in this position, a hydraulic leak in either system could bleed away all your fluid and you'd be left with no control at all.

Foreseeing that a mechanic might forget this handle sometime, our engineers put in a "fool-proofer." That's the long sliver of aluminum. It is arranged to shove the handle forward automatically when the door is closed. A little emphasis on the importance of this handle might not be amiss when talking to your crew chief. Here's why: Our flightline mechanics report that this "fool-proofer" is not quite, just mostly. If a man goes at it right he can beat it. So, anytime that safety wire on the handle is broken, it wants to be wired back solid before the door is shut for any reason.

Ample Fluid Helps. Anytime you're flying an airplane, the controls of which are completely hydraulic, it is well to make sure that the fluid level is up. And take a look at the hydraulic accumulator pressure. It should be 1000 pounds plus or minus 25.

Among the things we check closely are the automatic pitch control vanes. Don't wrench at them, just give them

Vain . . . . (YOU HOPE)



a little twist to make sure they are working free and easy.

There are circuit breakers in both the electrical and the electronics bay. Be sure they are all punched.

In production flight we used to have a real crystal ball act. By pushing a pencil up through the two witness holes in the belly, aft, you can tell if your drag chute is in place and the D-ring properly located. We'd learned, by pencil probing, to tell when the D-ring wasn't placed properly. By this we could predict drag chute failure nine times out of ten.

But then production figured out a new positioning tool and the D-ring is placed on the money every time. We haven't had a drag chute failure in moons. But we still poke a pencil in the holes just to be sure. In the aft hole, the pencil should go up not more than an inch and you will feel something springy. This shows you the drag chute is there.

In the forward hole, when you poke the pencil up you'll bump into a dead end. This is the D-ring. If the pencil goes up more than an inch the D-ring is misplaced and it'll be "laundry on the runway" at touchdown.

We normally pull our own pins from the stiff-knees on the walk-around and hand them to the crew chief. Incidentally, if this is part of your SOP, we've tried to make the job easier. You no longer bust your knuckles pulling the pins. The stiff-knee pins have husky handles on them that make them easy—and bloodless—to pull.

Nosewheel steering works fine on the F-104 if it is connected. Be sure you see an open eye between the nose gear scissors. Opportunity knocks constantly for someone to forget this since the scissors are moved to the lower eye for towing.

Travel Is Short. The "liquid-spring" shock struts on the F-104 have a short travel so it is well to measure them and make sure they are up, since appearances may deceive you. Fortunately, most of you have a handy measuring stick on your hand. From the middle knuckle to the tip of your little finger is pretty close to two inches. This is what the nose gear shock strut should measure. The distance between your middle knuckle and outer knuckle on your little finger is a shade over 1.4 inches and this is what the main gear shock struts should measure.

You'll find generally that the F-104 is a precision-made piece of equipment and it is solidly built. Anything loose or flexible, as a generalization, should be regarded with suspicion.

This should give you a lead or two on things to look for when you start your walk-around. So it's about time to put on your spurs and climb into the cockpit. ▲

THE FASTER YOU GO, THE FASTER YOU GO,

Capt. Joseph A. Rea, Propulsion Laboratory, Wright Air Development Center, ARDC.

The latest breed of high performance aircraft is being restricted, not by airspeed, but by temperature due to high Mach operation.

The April 1955 issue of Flying Safey Magazine carried on article by Mr. Tony LeVier, then Chief Test Pilot for Lockheed Aircraft Corporation, entitled "Looking at the Maching Birds." At that time supersonic flight had become a reality, and the article covered the subject as far as aerodynamics and operational characteristics of the airframe are concerned. Here is a companion piece from the propulsion viewpoint, emphasizing engine temperature limits at high Mach airspeeds, why they occur and the importance of operating the aircraft within design limits.

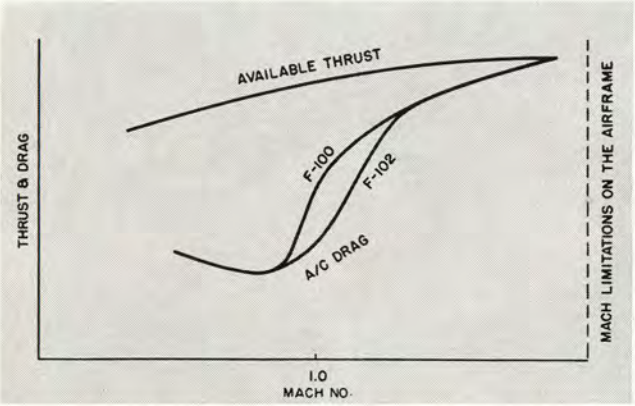


Figure 1. Thrust-drag vs. Mach number relationship on earlier aircraft.

The drag and available thrust vs. speed curves have, in recent years, begun to appear as those in Figure 1. The curve representing the F-100, the first weapon system designed for supersonic flight, has a sharp rising drag curve through Mach one. Then came the area rule, or "coke bottle shape," which effectively moved this drag rise just a little to the right. With the slope a little less steep, the problem of "going thru' the door" was made much easier.

In these examples, the airframe designer has been on safe ground for level flight operation in that the airspeed design limit could be placed outside the intersection of the drag and available thrust curves. The pilot was thus insured against exceeding the design limits.

Today, it is possible to "fly an airplane to pieces" in straight-and-level flight with a moderate power setting in terms of power lever angle. As you can see from Figure 2, this occurs because the already wide margin between drag and thrust available becomes larger as Mach number is increased—line number two is longer than line number one by an appreciable amount. (This margin is all important in determining the capabilities for climbing and accelerating.) The situation, which can be stated in many different ways, has been reduced to the descriptive and, in many instances, more appropriate term, "The faster you go, the faster you go."

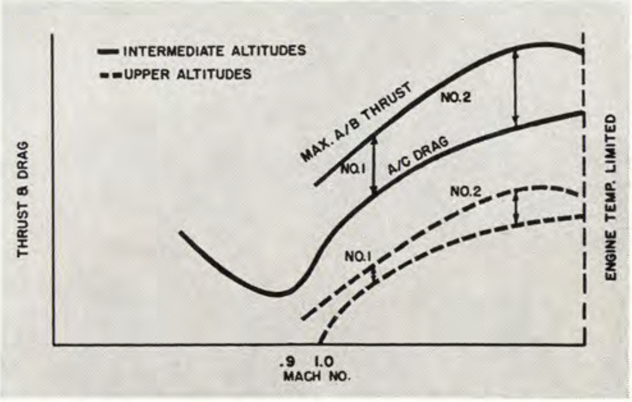


Figure 2.—Thrust-drag versus Mach number operating at altiude.

The thrust and drag vs. Mach number curves are presented in the Pilot's Handbook. A thorough understanding of these relationships and how they are affected by changes in altitude are both interesting and important to the pilot. As altitude increases, the entire thrust curve, in effect, "comes down to meet the drag curve" but the relative divergence of thrust and drag with increasing Mach number on new weapon systems become more noticeable. Because the weapon system has been designed for a certain high, supersonic "best climb," airspeed (Line No. 2, Figure 2) where excess thrust is greatest, it is expected that the excess will exhibit itself up to the power ceiling, at this optimum Mach number. And, so it does.

Suppose now you are at an altitude where the thrust and drag curves are getting close together, in a straight-and-level attitude, and wish to accelerate to this best climb speed. You "firewall it" and as the Mach needle approaches your objective, it's back on the "go handle" to stabilize out. But whoa! You overshoot the desired airspeed and, likely as not, the engine Mach limitations.

That decrease in power setting just isn't enough, and the resulting sensation is like being on a bobsled run with no brakes—plenty of acceleration but no means of slowing down (a highly unstable state of affairs). And so you are learning the finer aspects of excess thrust. Call it lack of anticipation, under-compensating or what you will, this has proved to be quite a surprise to the uninitiated. So, Beware!

The probabilities of failure and the type of failure can be pretty well predicted when the Mach limit is exceeded. Wind tunnel model-testing, flight data, and so on, are most adaptable to this sort of information. The same has not been true for the power plant designer. In this case, the wind tunnel is not nearly so adaptable because of the large masses of air consumed. Engines are not adaptable

THE FASTER YOU GO, THE FASTER YOU GO,

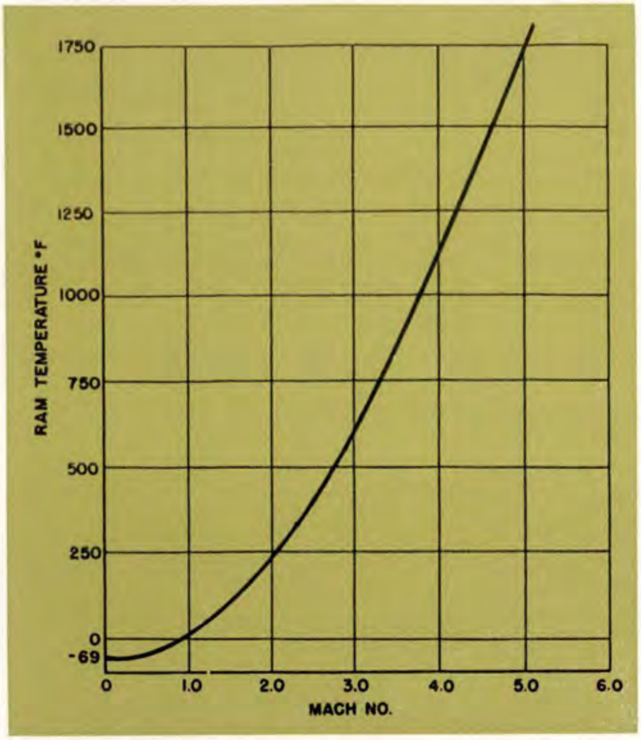


Fig. 3. Temperature vs. Mach number between 36,089 and 82,021 ft.

to scaling, and the variables which affect engine performance are more complex. Only recently has the drag curve on the airframe been low enough and the available thrust curve sufficiently high that there has been excess thrust at the maximum airframe speed limit. This is just the beginning. Future weapon system designs are accenting this condition.

We now find ourselves limited in speed at intermediate altitudes, not because of an airframe structural failure, but because certain engine parts cannot endure temperatures associated with excessively high Mach numbers. Designers say, "We are temperature-limited rather than thrust-limited."

As an illustration, Figure 3 shows the ram temperature at 36,089 feet as a function of Mach number. The model atmosphere above 36,089 feet exhibits a constant temperature up to 82,021 feet. Because of this, Mach number and ram temperature (temperature of the air entering the first stage of the compressor) become synonymous between these altitudes, i.e., a certain Mach number represents a certain compressor inlet temperature. Note that the terminology is "model atmosphere"—a device used in design specification. Actual conditions can be expected to vary as much as ± 30°F. from this ideal as a result of climatic and seasonal variations in temperature.

While temperatures up to Mach 3 on this curve are not in themselves excessively high, it doesn't take much imagination to picture what can happen when a compressor, operating on the upper limits as far as temperatures of materials is concerned, with an inlet temperature of 250°F. is "edged across" the Mach limit (see Figure 4).

Here we see that the extremely valuable commodity, excess thrust, which can be fully exploited at lower velocities, becomes a hazard to flight when translated in terms of speed beyond the Mach limitations.

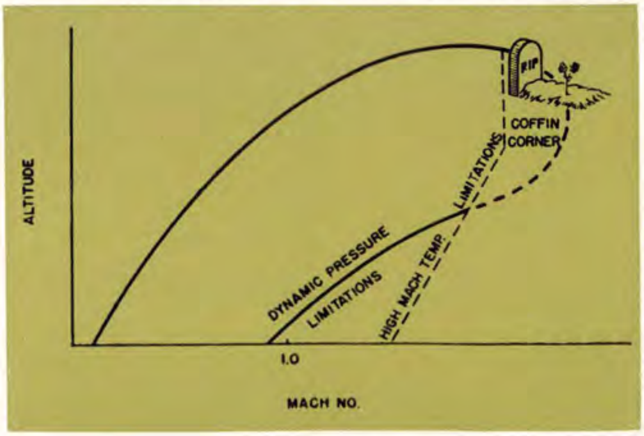
Of course, the engine manufacturer can do things such as build compressors using turbine materials, and this is actually the trend. In so doing, there are weight and cost penalties, however, so the designer is always searching for materials with optimum strength-weight ratios which will withstand ever-increasing, high-temperatures.

Another way of illustrating the situation can be shown by a typical operating envelope of the modern, manned, weapon system, Figure 4. Again remembering that a particular envelope is assuming a model atmosphere, it is seen that dynamic pressure limitations form the lower boundary and the top is formed by minimum speed and altitude limitations. The right-hand side is a straight, vertical line above 36,089 feet and can continue on up through 82,021 feet, depending on the particular weapon system (the temperature of the model atmosphere begins to increase with altitude at 82,021 feet). It is so situated today because of temperature limitations on the turbojet engine. Below 36,089 feet, the temperature limitation is associated with varying Mach number down to sea level. (Here we observe that because of this variance, climatic variations and normal seasonal changes, the Mach meter is not a good trouble-indicator.)

The aptly named "coffin corner" is a challenge to the gas turbine development, and progress is being made toward raising the temperature limitations on engines. Advancement is slow, however, and beset by the law of diminishing returns. The developments are very costly.

Temperature limitations are well-established and represent the best "in-production," metallurgical technology. Because of them, the ultimate speeds for the air-breathing, rotating-compressor-type engine with known alloys, can be definitely forecast.

Fig. 4. Operating envelope for modern high performance craft.



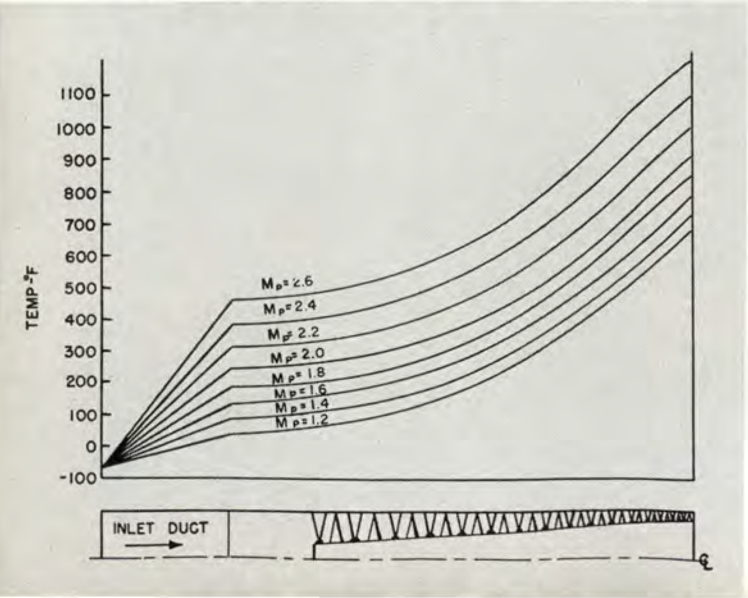
It must be impressed upon the modern "high-performance-type" operator that any violation of the temperature limit is "deadly," the perturbing part of the situation being that the one who commits the crime stands a good chance of avoiding the consequences. Thermal fatigue, thermal shock, and stress-rupture information on materials are sciences which have not been reduced to practicality in the engine business. For example, the well-established S816 alloy used in the fabrication of turbine blades for the J-47 engine has a rating which states that it will withstand 20,000 psi stress for 30,000 hours at 1500°F. This is factual information obtained under laboratory conditions and indicates that there should be no problem with the "bucket" design on the J-47.

Experience has shown that under some conditions of over-temperature operation, life can be measured in seconds. There are volumes of technological data on "hot parts" alloys. Correlating this information to expected life under operating conditions has not yet been successfully accomplished. One of the major problems is ascertaining and recording time at over-temperature (with stress) under actual conditions, on an engine. Another is the determination of actual stresses while operating.

The field of metallurgy is an involved one and there are many factors which are beyond the scope of this discussion. The point to be made here is that heat-soaking a given alloy above a certain range of temperatures, while under stress, will materially reduce its maximum allowable stress (see Figure 6). This family of curves illustrates the three-dimensional aspect of the problem. Note that both the stress and time are on logarithmic scales (a little bit can mean a lot in either direction). Each line shows that the stress required to rupture the material is a function of time for a particular temperature. The grouping is representative of materials used in "hot parts" manufacture of modern gas turbines and again illustrates the dangers involved in just slightly exceeding the maximum Mach or temperature limitations. It is emphasized that this stress-rupture curve is only representative of materials used in late model engines. If you want to become really sharp on the subject, a good place to start would be with the curves for the specific material in your particular engine.

Materials *can* exceed the temperature limitation for certain periods of time without immediately failing. There is, however, a deterioration in maximum allowable stress regardless of the length of time at an over-temperature. Ignoring this is like fudging on the bank account, never knowing when the first check will bounce.

Fig. 5. Typical temperature increase across compressor at 35,000 ft.



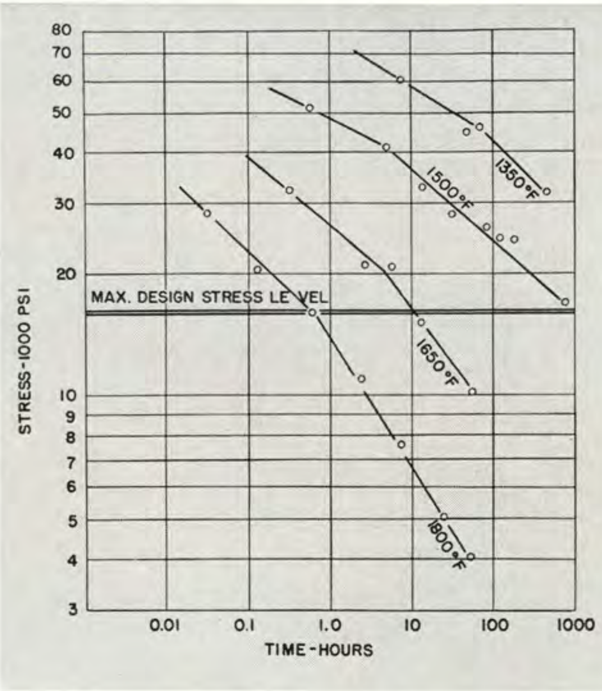


Figure 6. Stress-rupture curves for S816 alloy metal.

The high-temperature condition could be avoided. The available-thrust curve could be biased in such a manner that the weapon system would never exceed the high Mach, temperature limitations. In considering this, the old cliche "You can't have your cake and eat it too" was never more true. The excess thrust is highly desirable for fast acceleration and added rate-of-climb. Modern design has given the pilot an additional maneuver capability at altitude. Where he was once limited to deceleration and dive, he can now climb with equal advantage. We have increased our "passing capability," if we may belabor a point and steal a sales pitch from the automobile industry. There is no known method for successfully retaining this acceleration capability and still make certain that the weapon system will remain behind the temperature limit.

The dynamic pressure limitation is applicable to the engine as well as the airframe. On the engine this means "brute force" bending of inlet guide vanes, rotor and stator blades, blown combustion chambers, distorted nozzle diaphragms, bulged oil tanks, and so on, when the limit is exceeded.

In dynamic limitations, as with temperature limitations, the advent of excess thrust with high supersonic speeds has brought about characteristics which require modification of the usual or normal pilot techniques. One of the most recent and important causes for concern are the phenomena called "inlet buzz" and "twin duct instability." Both can cause compressor stall, or compressor stall may instigate an inlet buzz.

The first term, inlet buzz, has been applied to the low-frequency pressure pulsations occurring in the engine inlet duct when the design rate of air flow has been disturbed or exceeded. The situation is analogous to airfoil stall, since both are aerodynamic devices and in both instances the phenomena can occur when the design air flow rates are exceeded or the flow pattern is disturbed. Air flow can be disrupted when, for some reason such as sudden decrease of RPM or compressor stall, the rate of air flow through the engine does not match the design duct rate. Both the pressure magnitude and frequency of pulsations can vary considerably. The pilot of fighter-type weapon systems will hear and feel a vibration, during buzz, which will closely resemble a compressor stall.

The second phenomenon, twin duct instability, occurs on designs where two ducts feed a common air chamber or compressor intake. An asymmetrical condition arises when one duct stalls out, thereby creating spillage of air which results in turbulent flow across some portion of the wing or control surface with consequent abnormal flight characteristics. Here, as with inlet buzz, the problem is magnified with a reduction of engine air flow, and the abnormal or unusual flight characteristics may result in excursions in yaw and roll which can be most uncomfortable at supersonic speeds.

The magnitude of these excursions depends on many parameters such as angle of attack, Mach number, engine flow, pilot input to the controls, operation of automatic stability devices, inlet geometry, and so on. The condition will generally be more prevalent and acute at high supersonic airspeeds while at the intermediate altitudes. Under ordinary circumstances, there is not a safety of flight hazard. Failure of automatic stability devices or pilot-induced magnification could lead to exceeding the airframe structural placards, however.

The discussion now comes down to the point of recommendations for best course of action. Undoubtedly, the reader has by this time concluded that "all is lost!"

In reality, the price of poker has gone up but the odds are still in favor of the driver, provided he learns and abides by the flight envelope of his particular bird. The classic "Wonderful One-Horse Shay" design concept, where the machine lasted one hundred years and then crumbled into dust, has never been duplicated in the engine business. Some components are structurally superior to others. This fact places an operational limitation on the engine. When limitations are exceeded, corrective action *must* be taken. They are well-defined and laid out in appropriate Tech Orders (Dash One, Pilot's Operating Handbook for any particular weapon system). As far as "hot parts" are concerned, don't fail to make a notation in the Form 781 of temperature attained and for how long, when there is any possibility of over-temperature.

Since the Mach meter cannot be relied on for keeping within temperature limitations, the question arises, how does the pilot remain within the envelope?

Because the limit is one of temperature, one might suggest the use of temperature-sensing devices. Actually, this is what is provided, but that isn't the end of the story. Certain inherent, mechanical, qualities of the sensor do not permit the transfer of heat energy at an equal rate under all conditions of flight and a lag is induced in the operator's indicated temperature. The knowledge and observance of this lag is another "must."

The procedures for getting out of or avoiding inlet stall are not at all straight-forward. This is one you must "play by ear." Paradoxically, it has been found that the better the performance of an inlet design, the more sensitive it is to inlet stall. For this reason, the designer chooses a compromise configuration which gives high performance and is perfectly free of inlet stall under the majority of circumstances. As in wing stall, duct buzz is to be expected under some operating conditions. The real "kicker" is, how does one distinguish it from compressor stall? Pilot experience will be the determining factor here, and again there is some uncertainty. Some of the most experienced of experimental test pilots have mistaken duct buzz for compressor stall.

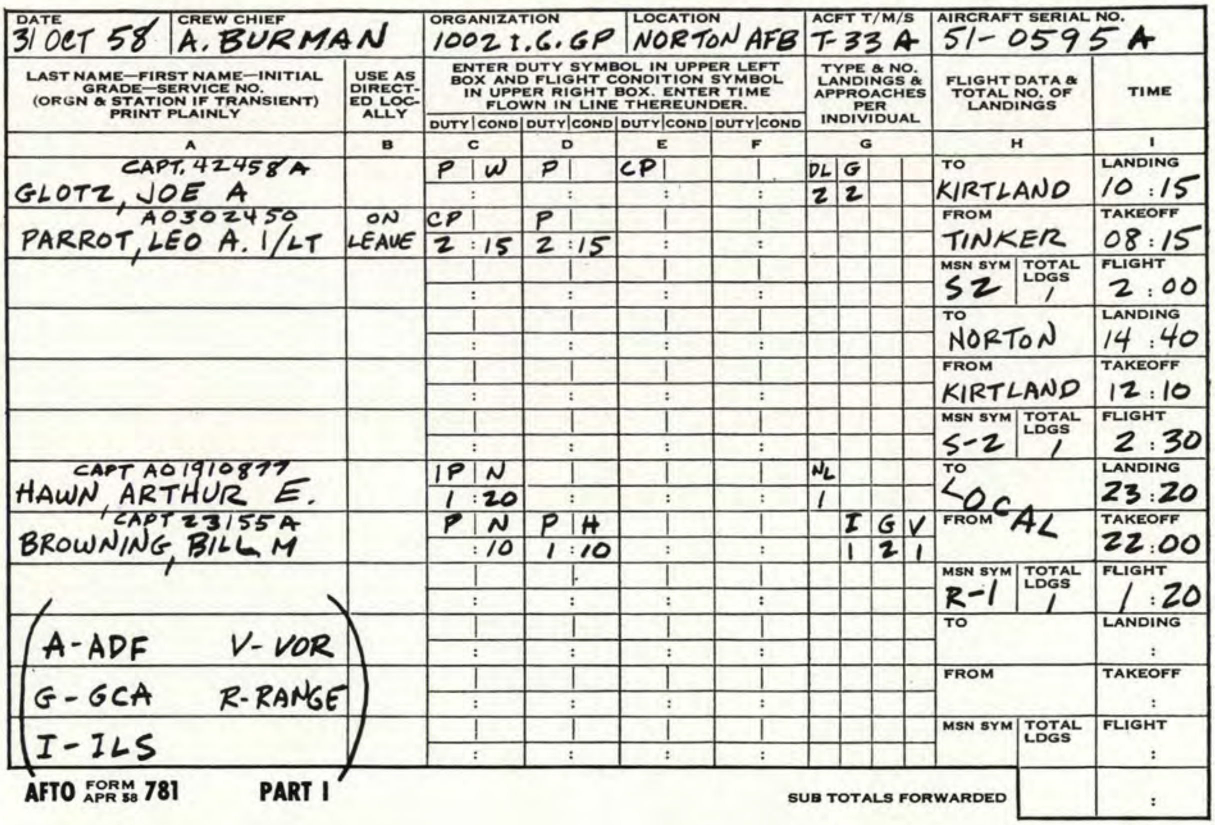
There is one maxim which will hold invariable for duct stall. KEEP ENGINE AIRFLOW HIGH. For those who have been indoctrinated with the procedure of pulling back on the throttle to correct a compressor stall, this is an apparent contradiction. Some of the current engines have a fuel control with which the RPM cannot be reduced significantly at high supersonic speeds. Pulling the power lever back to idle position under this condition will not significantly reduce engine RPM. This type of control works toward maintaining a constant high rate of airflow and thereby aids in suppressing duct stall.

Other of the modern engines will decrease the RPM when the power lever is retarded from "full afterburner" setting on back. On this latter design, the power lever should not be retarded below military RPM to correct a buzz condition. If additional deceleration is required beyond coming out of afterburner, it should be obtained by a pullup, a turn or by use of speed brakes. The thing to remember is that a decrease in engine RPM will aggravate duct stall.

The modern weapon system is a pretty thoroughly dreamed-up, thought-out, designed, fabricated, assembled, tested, "pea-picked," modified, tested and re-tested piece of hardware. There just isn't much about it that someone doesn't know and hasn't put down on a piece of paper. These problems, while being new, have a solution which is as old as flying itself. Know your bird!

Today, we have temperature limitations on engines. This is a problem, but in stating it we do not imply that all other problems are inconsequential. Airframe stability, duct flow, controls design and how to keep them cool, how to maintain temperatures of fuels and lubricants within safe operating limits, how to keep the aircraft structure itself cool, are just a few of the myriad problems facing the designer. These and many more have been considered and worked on a great deal. They're still problems which could compete with those of temperature-limited engines in the near future.

In the final analysis, the major problems confronting the development of present-day types of manned weapon systems are those concerned with high temperatures. For the air-breathing, rotating-compressor engines, this is a formidable barrier, but there is *still* profitable development work ahead before the ultimate in design is reached. With the solution of these and other problems will come more and faster gas turbines for the future. ▲



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

LAST NAME—FIRST NAME—INITIAL GRADE—SERVICE NO. (ORGN & STATION IF TRANSIENT) PRINT PLAINLY	USE AS DIRECTED LOCALLY	ENTER DUTY SYMBOL IN UPPER LEFT BOX AND FLIGHT CONDITION SYMBOL IN UPPER RIGHT BOX. ENTER TIME FLOWN IN LINE THEREUNDER.								TYPE & NO. LANDINGS & APPROACHES PER INDIVIDUAL			
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CAPT. 42458A GLOTZ, JOE A		P	W	P		CP				DL	G		
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FLIGHT DATA & TOTAL NO. OF LANDINGS		TIME
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TO NORTON		LANDING 14:40
FROM KIRTLAND		TAKEOFF 12:10
MSN SYM S-2	TOTAL LDGS 1	FLIGHT 2:30
TO LOCAL		LANDING 23:20
FROM		TAKEOFF 22:00
MSN SYM R-1	TOTAL LDGS 1	FLIGHT 1:20
TO		LANDING :
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MSN SYM	TOTAL LDGS	FLIGHT :
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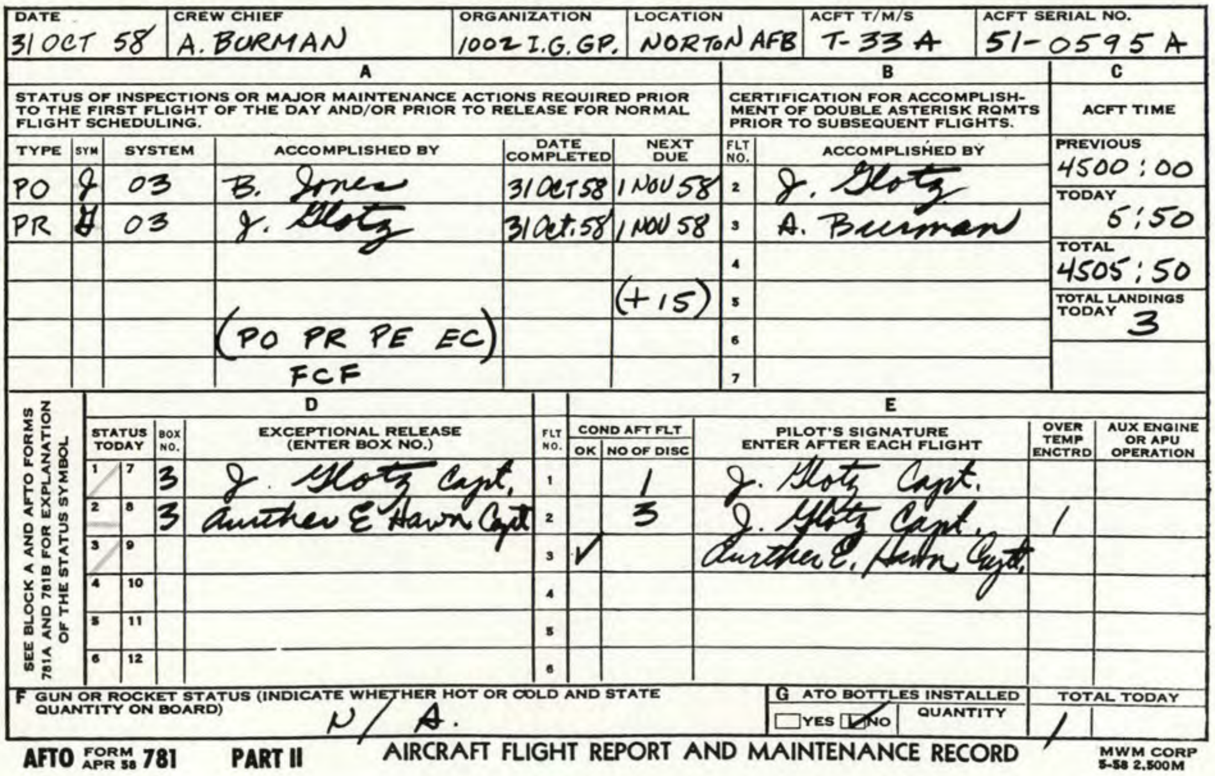
AFTO FORM APR 58 781 PART I

Change of Form



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						B		C
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.						CERTIFICATION FOR ACCOMPLISHMENT OF DOUBLE ASTERISK RQMTS PRIOR TO SUBSEQUENT FLIGHTS.		ACFT TIME
TYPE	SYM	SYSTEM	ACCOMPLISHED BY	DATE COMPLETED	NEXT DUE	FLT NO.	ACCOMPLISHED BY	PREVIOUS 4500:00
PO	J	03	B. Jones	31OCT58	1NOV58	2	J. Glotz	TODAY 5;50
PR	J	03	J. Glotz	31Oct.58	1NOV58	3	A. Burman	TOTAL 4505;50
						4		TOTAL LANDINGS TODAY 3
					(+15)	5		
			(PO PR PE EC)			6		
			FCF			7		

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

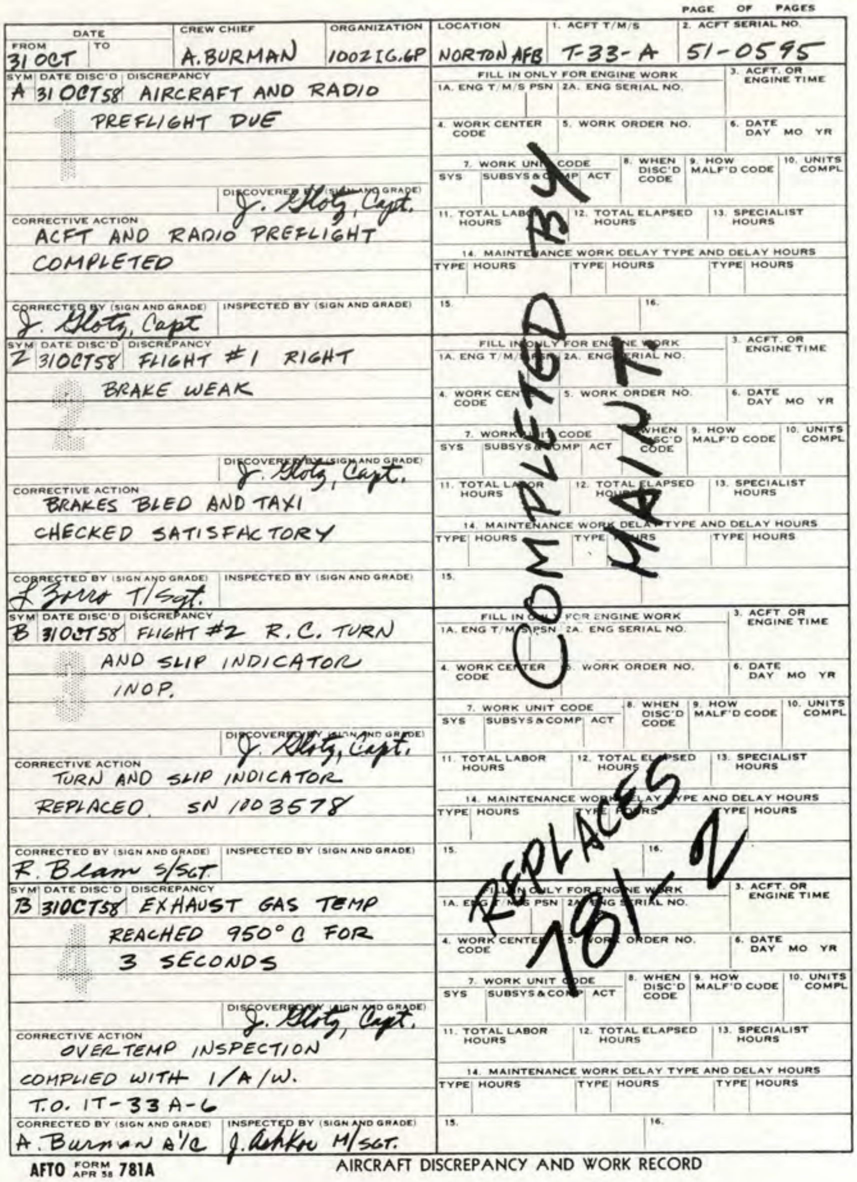
D				E					
STATUS TODAY		BOX NO.	EXCEPTIONAL RELEASE (ENTER BOX NO.)	FLT NO.	COND AFT FLT		PILOT'S SIGNATURE ENTER AFTER EACH FLIGHT	OVER TEMP ENCTRD	AUX ENGINE OR APU OPERATION
					OK	NO OF DISC			
1	7	3	J. Glotz Capt.	1		1	J. Glotz Capt.		
2	8	3	Aurther E Hawn Capt	2		3	J. Glotz Capt.	1	
3	9			3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

AFTO FORM APR 58 781 PART II AIRCRAFT FLIGHT REPORT AND MAINTENANCE RECORD MWM CORP 5-58 2,500M



PAGE OF PAGES

DATE FROM: 31 OCT — TO:
CREW CHIEF: A. BURMAN
ORGANIZATION: 1002 IG.GP
LOCATION: NORTON AFB
1. ACFT T/M/S: T-33-A
2. ACFT SERIAL NO.: 51-0595

SYM: A — DATE DISC'D: 31 OCT 58 — DISCREPANCY: AIRCRAFT AND RADIO PREFLIGHT DUE
DISCOVERED BY (SIGN AND GRADE): J. Glotz, Capt.
CORRECTIVE ACTION: ACFT AND RADIO PREFLIGHT COMPLETED
CORRECTED BY (SIGN AND GRADE): J. Glotz, Capt
INSPECTED BY (SIGN AND GRADE):

SYM: Z — DATE DISC'D: 31 OCT 58 — DISCREPANCY: FLIGHT #1 RIGHT BRAKE WEAK
DISCOVERED BY (SIGN AND GRADE): J. Glotz, Capt.
CORRECTIVE ACTION: BRAKES BLED AND TAXI CHECKED SATISFACTORY
CORRECTED BY (SIGN AND GRADE): L. Zorro T/Sgt.
INSPECTED BY (SIGN AND GRADE):

SYM: B — DATE DISC'D: 31 OCT 58 — DISCREPANCY: FLIGHT #2 R.C. TURN AND SLIP INDICATOR INOP.
DISCOVERED BY (SIGN AND GRADE): J. Glotz, Capt.
CORRECTIVE ACTION: TURN AND SLIP INDICATOR REPLACED. SN 1003578
CORRECTED BY (SIGN AND GRADE): R. Blam S/SGT.
INSPECTED BY (SIGN AND GRADE):

SYM: B — DATE DISC'D: 31 OCT 58 — DISCREPANCY: EXHAUST GAS TEMP REACHED 950° C FOR 3 SECONDS
DISCOVERED BY (SIGN AND GRADE): J. Glotz, Capt.
CORRECTIVE ACTION: OVERTEMP INSPECTION COMPLIED WITH I/A/W. T.O. 1T-33A-6
CORRECTED BY (SIGN AND GRADE): A. Burman A/C
INSPECTED BY (SIGN AND GRADE): J. Ashkov M/SGT.

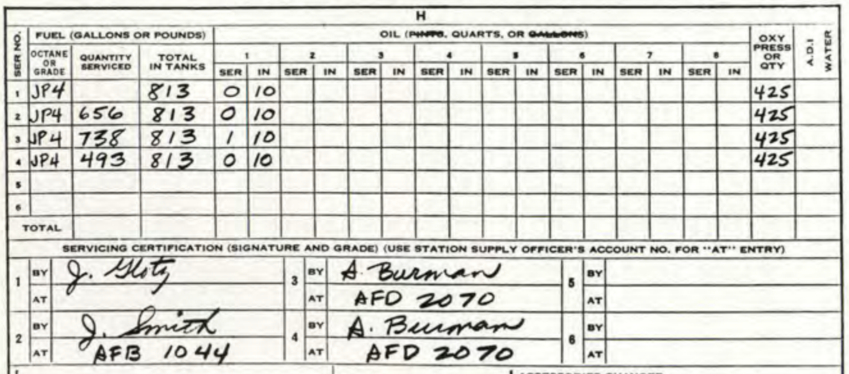
FILL IN ONLY FOR ENGINE WORK: 1A. ENG T/M/S PSN — 2A. ENG SERIAL NO. — 3. ACFT. OR ENGINE TIME
4. WORK CENTER CODE — 5. WORK ORDER NO. — 6. DATE DAY MO YR
7. WORK UNIT CODE: SYS — SUBSYS & COMP — ACT — 8. WHEN DISC'D CODE — 9. HOW MALF'D CODE — 10. UNITS COMPL
11. TOTAL LABOR HOURS — 12. TOTAL ELAPSED HOURS — 13. SPECIALIST HOURS
14. MAINTENANCE WORK DELAY TYPE AND DELAY HOURS: TYPE HOURS — TYPE HOURS — TYPE HOURS
15. — 16.

COMPLETED BY MAINT.

REPLACES 781-2

AFTO FORM APR 58 781A — AIRCRAFT DISCREPANCY AND WORK RECORD

Below is shown data which appears on reverse side of AFTO Form 781,



H

SER NO.	FUEL (GALLONS OR POUNDS)			OIL (~~PINTS~~, QUARTS, OR ~~GALLONS~~)																OXY PRESS OR QTY	A.D.I.	WATER
	OCTANE OR GRADE	QUANTITY SERVICED	TOTAL IN TANKS	1		2		3		4		5		6		7		8				
				SER	IN	SER	IN	SER	IN	SER	IN	SER	IN	SER	IN	SER	IN	SER	IN			
1	JP4		813	0	10															425		
2	JP4	656	813	0	10															425		
3	JP4	738	813	1	10															425		
4	JP4	493	813	0	10															425		
5																						
6																						
TOTAL																						

SERVICING CERTIFICATION (SIGNATURE AND GRADE) (USE STATION SUPPLY OFFICER'S ACCOUNT NO. FOR "AT" ENTRY)

1 BY J. Glotz
AT
2 BY J. Smith
AT AFB 1044
3 BY A. Burman
AT AFD 2070
4 BY A. Burman
AT AFD 2070
5 BY
AT
6 BY
AT

I

J ACCESSORIES CHANGED

RE-MOVED	INSTL	ACCESSORIES & POSITION	SERIAL NO.	ACCRUED OR PREV OPR TIME	CHANGED BY

COMPLETED BY MAINT.

Out at the ol' ball park, young lads continually stroll up and down the aisles making their pitch, "Ya' can't tell the players without a scorecard, folks! Get ya' scorecard here!"

Well sir, that's what we're doing, sorta. The Air Force has a new "scoreboard" these days, and maintenance men need pilots' help to fill it out properly. Only then can they tell what's going on inside the birds.

Oh yes, the Form Five clerks have to use it too, for your pay purposes, so pay attention.

The whole deal is spelled out in T. O. 00-20A-1, dated 1 July 1958. It has a very imposing title: "Aircraft Inspection System, Preventive Maintenance Policies and Procedures, and Records Administration."

Section V, "Maintenance of AFTO 781 Series Forms," is the crux of the issue, as far as pilots are concerned, so it's a pretty good idea to read it over carefully. Much more responsibility has been placed on the individual pilot in the new forms, so knowing what to do and when to do it can save you, or one of your friends from busting a bird.

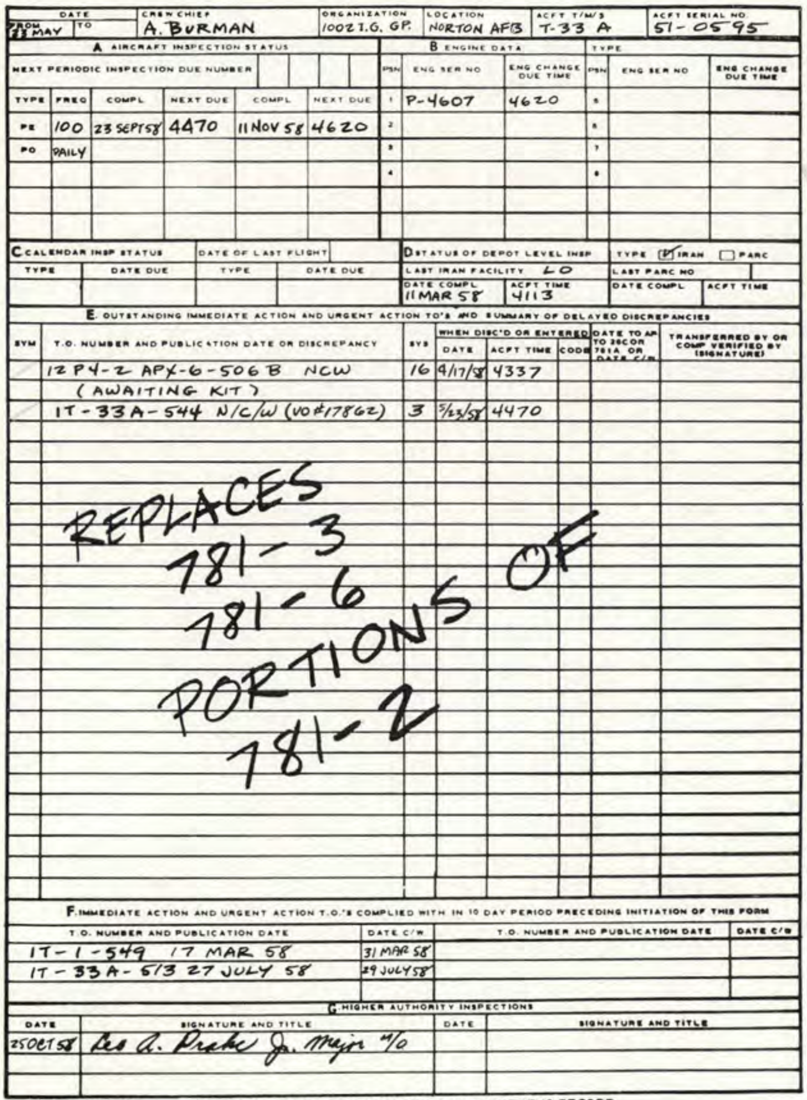
All of the new forms to be used are illustrated in the Tech Order and complete instructions as to how they should be filled out are printed in step-by-step order.

Now, for the business at hand. The AFTO Form 781, Aircraft Flight Report and Maintenance Record is a dual-purpose, perforated form consisting of Parts I and II. The upper half of the form, Part I, front and back, serves as the flight report portion and is used for recording factual data.

In this regard, Form Five clerks tell us that pilots continually are making mistakes in Column G, Type and No. Landings and Approaches per Individual. All types of approaches and landings are coded under the new system and care must be taken to insure that the right code is inserted in the right column.

Part II, of the new form is a front-and-backer, and is used to record maintenance and servicing performed or required on any particular piece of flying machinery. It gives you the STATUS of that bird and provides a record of all inspections performed or required.

As the illustration shows, our fictional airplane driver, Capt. Joe A. Glotz, has to sign his name five times, repeat, five times on the front side of Form 781, Part II, during his hypo-



DATE FROM	TO	CREW CHIEF	ORGANIZATION	LOCATION	ACFT T/M/S	ACFT SERIAL NO.
23 MAY		A. BURMAN	1002 I.G. GP.	NORTON AFB	T-33 A	51-0595

A AIRCRAFT INSPECTION STATUS

NEXT PERIODIC INSPECTION DUE NUMBER

TYPE	FREQ	COMPL	NEXT DUE	COMPL	NEXT DUE
PE	100	23 SEPT58	4470	11 NOV 58	4620
PO	DAILY				

B ENGINE DATA — TYPE

PSN	ENG SER NO	ENG CHANGE DUE TIME	PSN	ENG SER NO	ENG CHANGE DUE TIME
1	P-4607	4620	5		
2			6		
3			7		
4			8		

C CALENDAR INSP STATUS — DATE OF LAST FLIGHT

TYPE	DATE DUE	TYPE	DATE DUE

D STATUS OF DEPOT LEVEL INSP — TYPE ☑ IRAN ☐ PARC

LAST IRAN FACILITY LO — LAST PARC NO

DATE COMPL 11 MAR 58 — ACFT TIME 4113 — DATE COMPL — ACFT TIME

E OUTSTANDING IMMEDIATE ACTION AND URGENT ACTION TO'S AND SUMMARY OF DELAYED DISCREPANCIES

SYM	T.O. NUMBER AND PUBLICATION DATE OR DISCREPANCY	SYS	WHEN DISC'D OR ENTERED DATE	ACFT TIME	CODE	DATE TO AP TO 26C OR 781A OR DATE C/W	TRANSFERRED BY OR COMP VERIFIED BY (SIGNATURE)
/	12P4-2 APX-6-506B NCW	16	4/17/58	4337			
	(AWAITING KIT)						
/	1T-33A-544 N/C/W (VO#17862)	3	5/23/58	4470			

REPLACES
781-3
781-6
PORTIONS OF
781-2

F IMMEDIATE ACTION AND URGENT ACTION T.O.'S COMPLIED WITH IN 10 DAY PERIOD PRECEDING INITIATION OF THIS FORM

T.O. NUMBER AND PUBLICATION DATE	DATE C/W	T.O. NUMBER AND PUBLICATION DATE	DATE C/W
1T-1-549 17 MAR 58	31 MAR 58		
1T-33A-513 27 JULY 58	29 JULY 58		

G HIGHER AUTHORITY INSPECTIONS

DATE	SIGNATURE AND TITLE	DATE	SIGNATURE AND TITLE
25 OCT 58	Leo A. Drake Jr. Major M/O		

AFTO FORM APR 58 781B AIRCRAFT INSPECTION AND MAINTENANCE STATUS RECORD

thetical flight from Tinker to Kirtland to Norton.

One, he had to sign an exceptional release for Box #3 in the "Status Today" column of Block D.

Two, he had to sign off an "03" system inspection in Block A. As the T.O. states, an "03" system inspection is the "look" Phase of Scheduled Inspections, which includes all work such as greasing, and so on, included on work cards and minor fixes such as tightening clamps and connections, and unbuttoning and buttoning up the aircraft. These are a lot of big words meaning "thorough preflight."

Three, at Kirtland, he had to signify the condition of the aircraft after flight and list the *number* of discrepancies. (He then has to spell out the discrepancies on the new AFTO Form 781A and sign his name in the special "discovered by" block.)

Four, when the discrepancy is repaired, Captain Glotz has to signify that he accomplished a thorough preflight inspection involving "double asterisk" requirements in Block B. These requirements appear on the mechanic's work cards, but are also covered in the pilot's preflight cards. (This is usually required only when a pilot is away from his home station.)

Five, he has to go through the same routine as he did at Kirtland in Block E. You'll notice this time that he discovered three discrepancies. He's now back at the home station however, and the regular crew chief makes the corrections and the airplane is released for a flight by Captain Hawn, who has a "no sweater" as is indicated in Block E.

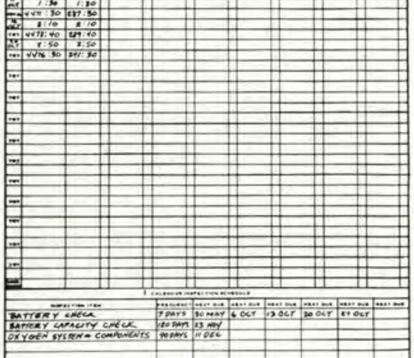
Captain Glotz, however, had to fill out the servicing certification which is found in Block H on the back side of Part II. So, all told, he's signed his name eight times. Whew!

Remember 'way back at Tinker, when Captain Glotz signed off a red diagonal. The diagonal was for a couple of Tech Orders which had not been complied with. Naturally, a pilot wants to know why the red diagonals. So, he can look on a new form, 781B, which, in Block E, lists the outstanding immediate action and urgent action Tech Orders. The form also lists, in Block F, immediate action and urgent action Tech Orders which were complied with in a 10-day period preceding initiation of the form. On the back side of 781B is listed airplane and engine operating time record and the calender inspection schedule.

The 781B contains certain data previously recorded on the Form 781-2, and all of the data previously recorded on 781-3 and -6, and is illustrated in the Tech Order.

So, there you are. It's the new look in the Form Department. As we've said, Section V, T.O. 00-20A-1 gives you the complete pitch. Read it. And, while you're at it, Section I contains a lot of good information which you may have forgotten—or, perish the thought, never knew about. ▲

Reverse AFTO Form 781B, below, shows operating records, calendar inspections due.



BATTERY CHECK	7 DAYS	30 MAY	6 OCT	13 OCT	20 OCT	27 OCT
BATTERY CAPACITY CHECK	120 DAYS	23 NOV				
OXYGEN SYSTEM & COMPONENTS	90 DAYS	11 DEC				

Bird Watchers Needed...

The type of men we need must be potential specialists in the field. Length of experience is not so important as willingness to work as long as the job requires without regard to specific schedules. "Sticktuitiveness" is essential.

A number of positions are open in the category of "Senior Bird Watchers." Applicants qualifying for advanced rating must be able to perform specialty with excellence and be able to direct, as well as teach, bird-watching essentials to less experienced personnel.

Physical standards are high. This is a necessity in view of the overall physical, as well as mental alertness required. Keen eyesight is highly desirable, although applicants properly fitted with glasses are acceptable —provided that glasses are constantly worn while on the job!

Pay is good although not so significant as bonuses payable when spotting is done at extremely close ranges in climbing or diving flight. No Union—no fees, no assessments. Degree of risk rapidly decreases with experience. Ability to recognize following species constitutes minimum acceptable experience: Gooney, Tee-, Big-Iron, Goonette, yellow breasted leadsled, and Bug Smashers.

Our Motto: **When you're through looking, you're through!**

*U.S. GOVERNMENT PRINTING OFFICE 481008