OCTOBER 1953

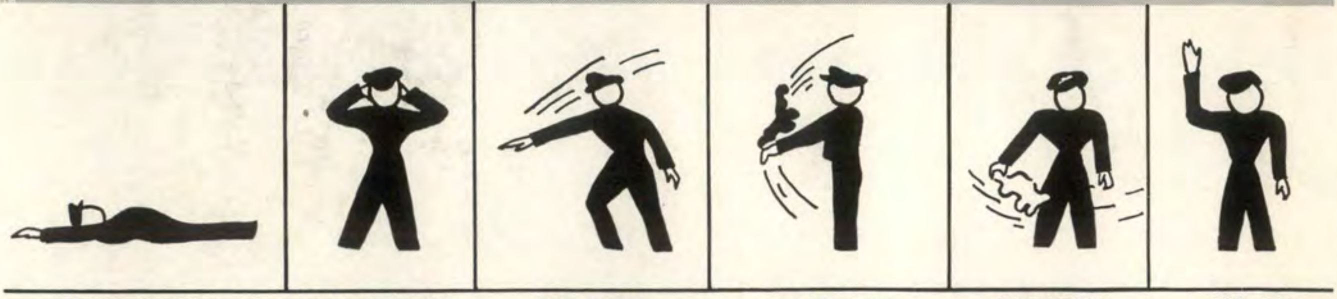
FLYING SAFETY

UNITED STATES AIR FORCE

CAN YOU READ THIS MESSAGE?

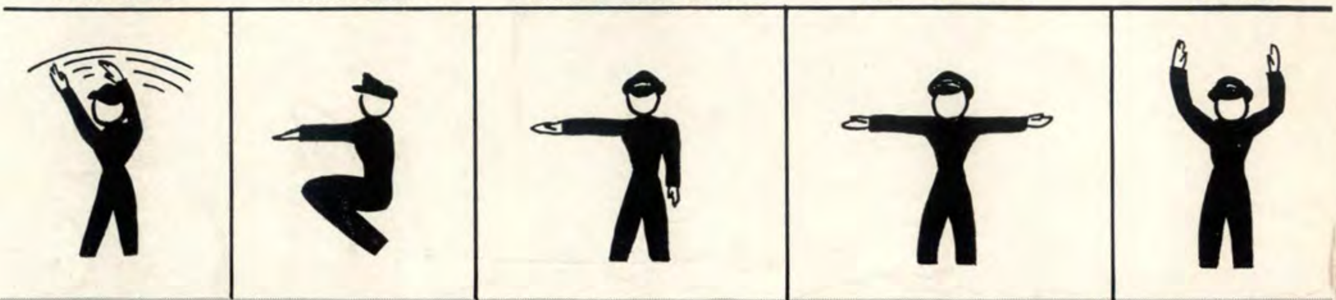
see page one . . .

BODY SIGNALS



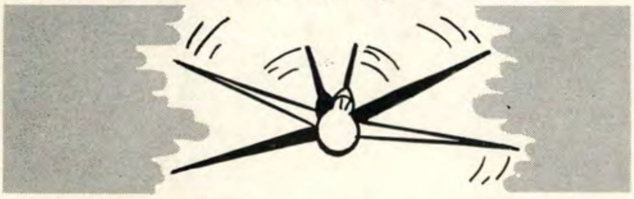
NEED MEDICAL ASSISTANCE	OUR RECEIVER IS OPERATING	USE DROP MESSAGE	AFFIRMATIVE (YES)	NEGATIVE (NO)	ALL OK. DO NOT WAIT

DO NOT ATTEMPT TO LAND HERE	LAND HERE	CAN PROCEED SHORTLY— WAIT IF PRACTICAL	NEED MECHANICAL HELP OR PARTS	PICK US UP— PLANE ABANDONED



STANDARD AIRCRAFT ACKNOWLEDGEMENTS

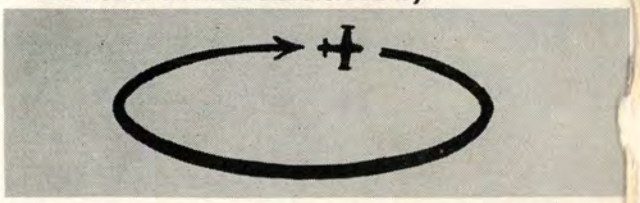
MESSAGE RECEIVED AND UNDERSTOOD: Aircraft will indicate that ground signals have been seen and understood by—



DAY OR MOONLIGHT: Rocking from side to side.

NIGHT: Making green flashes with signal lamp.

MESSAGE RECEIVED AND NOT UNDERSTOOD: Aircraft will indicate that ground signals have been seen but not understood by—



DAY OR MOONLIGHT: Making a complete right hand circle.

NIGHT: Making red flashes with signal lamp.

TIME can be all important in a survival experience. If you are down without radio communications the lives of injured personnel may depend on your ability to send and receive signals. Study and memorize body and panel signals and learn to recognize standard aircraft acknowledgments. Learn to use a signal mirror. Preparation and knowledge can save your life.

MEMORIZE THE "SIGNS FOR SURVIVAL" NOW!

Department of the Air Force
The Inspector General USAF
Major General Victor E. Bertrandias,
Deputy Inspector General

★ ★ ★

Brigadier General Richard J. O'Keefe
Director
Directorate of Flight Safety Research
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★ ★ ★

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VOLUME NINE

NUMBER TEN

FLYING SAFETY

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Here is the translation of the cover message spelled out in the International Ground-Air Emergency Code:

Aircraft Badly Damaged	Unable to Proceed	Require Doctor — Serious Injury	Probably Safe to Land Here

. . . flight through

THERE are many pilots and engineers, both military and civilian, with extensive experience in flying under actual icing conditions. From them we find that varied conclusions are drawn relative to aircraft icing, and the methods used in combating it. Aircraft icing is a very controversial subject. This article not only covers many known facts, but also includes the opinions of pilots and engineers with many hours of actual experience in icing conditions.

It is an established fact that ice forms when two conditions occur simultaneously. Moisture in liquid form must be present in the air and the effective temperature must be freezing or lower.

Since all clouds contain moisture in some form, you can expect icing if the cloud temperature is at or below freezing.

In some cases, light ice or frost forms when an aircraft flies from a cold area that has reduced the temperature of the airplane itself to freezing, into a saturated cloud area where the temperature is slightly above freezing.

Super-cooled water droplets can exist in the atmosphere in liquid state, surrounded by air of below freezing temperatures. This apparent phenomenon is caused by a combination of factors that prevent these droplets from freezing.

The surface tension of the drop, its salt content, and most important, the fact that the liquid is undisturbed, all are conducive to the droplet remaining in the liquid state. But once broken or disturbed, as when it strikes an airplane, it turns into ice. Actual flight tests have shown that water can exist in atmosphere temperatures of $-35°$ C. to $-40°$ C.

Severity of Icing

The severity and type of icing is determined by the size and number of the water droplets that strike the plane and the stability of the air that supports them.

When super-cooled drops are small in size, their surface tension is great. So great in fact, that some of them rebound from the aircraft when they strike, while others cling and freeze. When these super-cooled drops are large, they tend to splatter when they hit and then freeze. This results in a smooth, thin layer of ice.

The very fine moisture particles are the kind that form rime ice. This is the same kind of ice that you'll find on the coils of the old faithful kitchen refrigerator. Opaque in appearance and quite granular in form.

Rime ice in its purest form is found generally in stable weather conditions (stratus type clouds), where vertical motion is restricted. It is not too cohesive or very strong and can be broken off readily by use of the de-icer boots.

ICE!

Compiled from reports of an air transport survey of civil and military organizations by Colonel Rufus K. Ward, Directorate of Readiness and Material Inspection, 1002d Inspector General Group.

Rime ice tends to conform more closely to an airfoil section than does clear ice. The weight of rime per unit is less than clear ice, thus adding less weight to the gross weight of the plane. The greatest resultant danger is the added drag caused by the rough ice surface.

Clear ice is formed from large, super-cooled water droplets and is more dangerous at lower temperatures. It is tenacious, harder and smoother. It is difficult for de-icer boots to remove, once it has built up. It may at times take on a roughened appearance, but it is never granular. Remember this latter, when attempting to distinguish the nature of your super cargo. Actually, most ice is a mixture of rime and clear.

The airflow about the plane has little effect upon the pattern that clear ice will assume. It usually builds forward from the leading edge of the wing and has a decidedly adverse effect on aerodynamic performance.

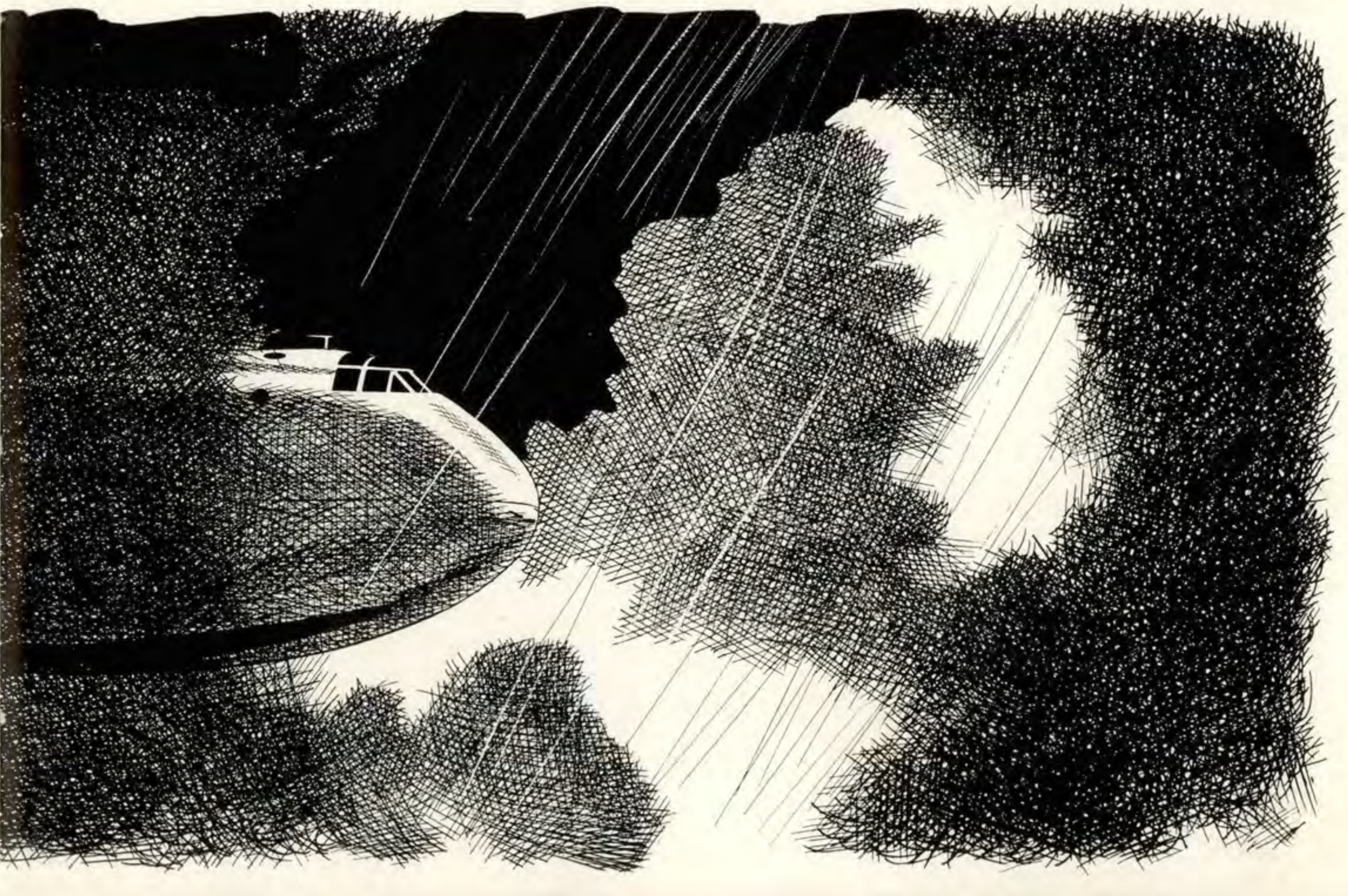
Clear ice usually starts forming by closely following the wing contour as does rime, but if allowed to go unchecked will build forward in a blunt, unstreamlined mass. It can build up remarkably fast, and has been known to force an aircraft down as little as 10 minutes after beginning to form.

In theory, zero degrees Centigrade being the freezing point of water, ice should not form above that value. However, in actual practice light ice or frost forms occasionally on aircraft in flight when outside air temperatures are slightly higher than freezing. The explanation for this centers around the fact that the metal skin of the aircraft is at or below freezing temperatures. As it flies into rain or moisture, with ambient temperatures slightly higher than freezing, the droplets strike the structure of the aircraft and splatter or spread, thus greatly increasing their area. This increases the radiation of heat from the water to the atmosphere and if this radiation plus evaporation is great enough, the temperature will drop to that of the skin of the plane and ice or frost may result.

Pilots should be a trifle leery of poking into areas where the ambient temperature is suspected of being higher than that of the plane, when the aircraft's temperature is below freezing.

Remember then, at outside air temperatures slightly higher than freezing, ice can form under ideal conditions.

It is a known fact that clear ice is more likely to form at temperatures nearer freezing than rime. The most critical range for the formation of clear ice generally extends downward from 0° C. to about −10° C. Below that, the water droplets will probably become smaller and not as apt to



form clear ice, except possibly in the tops of heavy cumulus clouds and thunderstorms.

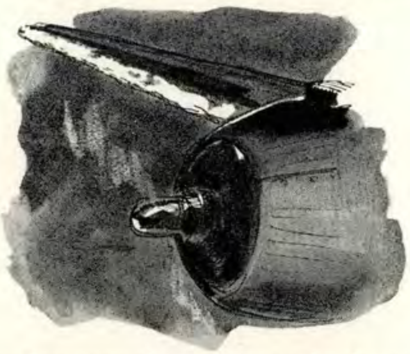
Below about −10° C. is the region of temperature at which rime ice is most likely to form.

Rate of Accumulation

Four factors govern ice build-up on a wing: the amount of super-cooled water present, the temperature of the air, the area and roughness of the surface exposed and lastly, the airspeed of the aircraft.

The first of these factors can be estimated in flight by the darkness of clouds encountered and their vertical development. Sharpness of the contour of clouds indicate active buildup and consequently larger amounts of water vapor in the air. In stratus clouds, the lower levels contain the most moisture.

It must be borne in mind that



under normal conditions, the lower the air temperature, the less relative amount of water will be present. However, it must also be remembered that as long as moisture is present there is some danger of icing.

It is known that any rough surface over which air flows not only cuts down the aerodynamic cleanliness of the plane, but also becomes an anchoring point for ice. Rough paint, rivet heads and frost particles are especially bad in this respect. Frost is unquestionably the worst of the offenders as ice will start building upon a frost base in short order.

Considerable controversy has been evidenced relative to speed versus amount of ice accumulation. There appears to be one simple solution to this problem. Remember this established fact: the *rate* of accumulation is always higher at higher airspeed, but, the *amount* of accumulation may be greater at slower speeds.

Although this will not come as a sudden shock to any pilot, we'd like to reiterate one of your earliest lessons on winter flying. The main effect of wing ice is to disturb the normal airflow about the wing. This results in loss of lift, in varying degrees, and increases the drag. Basically, it is the shape rather than the weight of ice that is the troublemaker. Admittedly, a half-inch of clear ice on a C-54 will increase the gross weight by approximately 6,500 pounds, but this will result in only about 20 gallons an hour increase in gasoline consumption, to maintain the same airspeed. However, what that extra 6,500 pounds of surplus weight will do to the stalling speed is something else again!

If you ever find yourself lugging that kind of a load, just bear in mind that you'll have to keep the old airspeed really on the high side while grinding around the traffic pattern. Keep the final hot, but don't run yourself fresh out of runway in the process of landing. There's a happy medium in this sort of predicament and only experience can give you the answer.

Pilots have been known to get into some rather peculiar attitudes and altitudes while attempting to run the gauntlet of severe icing. They have found that in trying to maintain a constant altitude, wing ice can cause the use of an increasing amount of power and angles of attack. Increased angles of attack subjects more area of the plane to icing, while increased power burns up more and more gasoline. The change in attitude allows ice to build up on parts of the airframe where de-icer equipment is not available. It's a vicious circle and the only answer is to change altitude.

Hazard of Wing Ice

The first indication of wing ice is a thin, white ribbon that develops along the leading edge of the wing. This strip gradually builds forward, upward and downward from its starting point around the center of the wing. Its initial effect upon performance is negligible, but as it builds and disrupts the airflow more and more, the hazard increases.

Although it is usually impossible to see the empennage from the cockpit, it may be safely assumed that if ice is observed forming on the leading edge of the wing, a simultaneous action is taking place on the tail surfaces. As ice forms on the vertical and horizontal stabilizers, an increased tendency to yaw will be noted.

Propeller ice will cause loss of efficiency in varying degrees. This condition will probably demand an increase in fuel consumption and will materially affect airspeed. If ice forms on one or two blades of a prop and not on others at the same time, a vibration moment will be established that can soon reach disastrous proportions.

Although ice will normally form on all prop blades at the same time, quite often it will break free or be thrown from one blade. Then the shaking act starts in earnest. Prop ice is likely at any time wing ice is picked up.

A propeller will rarely ice its entire length. Slower RPM is more conducive to a prop icing, but at normal cruising RPM, one-half to two-thirds of the length of the blade is as far as icing will extend. Even this amount of coverage can cause serious consequences and the wise pilot will employ preventive measures prior to entering known icing zones.

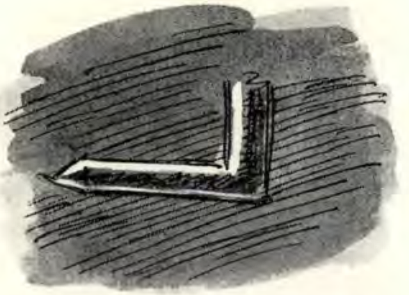
Turn on the propeller de-icers before entering icing areas, and coat the blades thoroughly with fluid. Then, retard the flow to about two quarts per hour, per propeller. This amount will be sufficient for normal icing. The problem here is not to exhaust the supply of fluid needlessly, but rather to use just enough to keep the blades free.

At night it is often difficult to determine if propeller ice is forming except by falling back on the old flashlight. Throw the beam on the whirling disk near the hub. Spinning, circular streaks will indicate that ice is forming. It is a fairly sure bet that if ice is forming on the spinner, it will be building up on the blades too.

Icing on props is indicated sometimes by engine vibration and loss of airspeed due to decreased propeller efficiency. If prop ice has caught you unawares, and de-icer fluid seems to have no effect, increase and decrease RPM several times, then use fluid to keep the blades clean.

Other Icing Problems

Pitot tube icing is extremely dangerous since it causes inaccurate readings of the pitot system flight instruments. It is the easiest to combat, however. The heating element in the pitot tube is sufficient to melt



ice under the most adverse conditions and should be used whenever icing conditions are anticipated.

Radio antennae icing can be serious and is relatively hard to prevent. Antennae icing can cause the mast to vibrate and the wires to sag and eventually break under the increased weight.

Ice bridging over the insulators and grounding the antennae to the plane's structure will cut off all communication. The only remedy is to change altitude and find a warmer stratum of air where the ice will melt. Sometimes it is possible to melt ice from the antennae by holding the transmitting key down and setting up sufficient induced current to do the job. It is not considered too practicable to depend upon this method of ice removal, however.

Windshield ice can be tolerated up to the point where a landing is contemplated, but from that point on, some means must be provided for forward vision. Many windshield deicing systems are currently employed, and all are workable to a certain degree. However, almost all manufacturers provide a sliding or hinged front or side window that may be employed in the event the windshield is iced up to a point where all mechanical aids fail to clear it properly.

Carburetor ice is as important as wing or prop ice in its adverse effect on the aircraft, and many pilots rate it first in importance.

Carburetor ice may be divided generally into three types: impact ice, throttle ice and fuel evaporation ice.

Carburetor ice does not depend upon the factors of visible moisture and freezing temperatures that characterize all other kinds of icing. It can form when there is not a cloud in the sky and at temperatures well above freezing, if the humidity is high enough. Because of the refrigerating effect of expanding air and vaporizing gases, temperatures in the adapter can be as high as 15° C. but still lower than the outside air temperature, and if humidity is great enough, ice will form in the carburetor.

Impact ice is formed when any kind of moisture in the air, whether from rain, snow or humidity, freezes upon contact with surfaces that are below freezing temperatures, in the same way that structural ice forms on the aircraft. The most dangerous phase occurs when it forms on the metering elements of the carburetor, affecting fuel-air ratio by either leaning or enriching it. Other vital areas are the walls and elbows of the airscoop, the screens, pre-heater valves and adapters.

Throttle ice is formed on or near the throttle when it is an intermediate position between full open and full closed. Near freezing particles of moist air in the air stream strike the metal surfaces around the throttle and freeze there. Generally temperatures most conducive to the formation of this type of ice are between $-1°$ to $+5°$ C. Ice can form at temperatures higher than this, but the metal is too warm for it to adhere to and no throttle ice results.

Fuel evaporation ice is similar to carburetor icing. To what extent this phenomena may occur depends largely upon the type of carburetor used, the quality of the fuel, the altitude flown and location of the fuel jets. All of these variables make the prediction of fuel icing rather difficult, but any moisture brought into the air scoop containing a high relative humidity can result in icing.

Affects Fuel Flow

Any of the above conditions, but especially fuel icing, can alter the existing fuel-air ratio, usually by enriching it, but occasionally leaning it, depending upon where the ice forms in the carburetor.

Ice can affect fuel flow by closing the adapter passage, causing some cylinders to run lean or rich by upsetting the fuel flow at the nozzle distributor. But regardless of what the specific cause is, the net result is loss of power and loss of airspeed, if level flight is maintained.

Indications of carburetor icing are loss of manifold pressure on constant speed props and loss of RPM on fixed pitch installations. This is the only sure indication and whenever icing is suspected, preventive action should be taken at once.

If manifold pressure changes, apply full heat for about one to two minutes, and after returning to the full cold position, see if your manifold pressure returns to the same value as before. If it returns to a higher reading, you had ice.

Any time that you are flying through regions of high moisture content, it is advisable to be on the lookout for the possibility of carburetor icing.

If ice has formed in the induction system and heat is not sufficient to melt it off, the induction system deicing alcohol or aniloil systems will usually do the trick. If heat is used properly, the icing has to be rather severe before it is necessary to use alcohol. Alcohol should be used only to remove ice, as small quantities of alcohol aggravate icing due to the temperature drop caused by the vaporization of the alcohol.

One final warning concerning carburetor heat: The amount of moisture in the air affects the ability of the carburetor heat control to effect a given rise in temperature. The higher the moisture content, the harder it is to raise the temperature. This is important to know when flying through heavy rain.

Also, if icing is encountered, move the carburetor heat control a few times to prevent the door from freezing in any one position.

The one basic rule to follow under *any* icing condition is — AVOID FLIGHT INTO KNOWN ICING AREAS WHENEVER POSSIBLE.

The easiest way to combat ice is to never get it in the first place. Naturally, this is not always possible, especially in military flying, but it should always be the first thought in combating icing conditions. Even in over-ocean flying, where a course can be altered considerably, it may be impractical to try to circumnavigate an icing zone because of the fuel in-

volved and the possibility of not being able to get a sight. So, if unable to avoid ice, the next best thing is to arm yourself with knowledge on how to combat ice.

If you have to ascend or descend through an icing layer, do so as quickly as possible. The longer you are exposed to icing, the more you are likely to pick it up. If practicable, a fast rate of descent at a relatively slow airspeed is best for descents, and in climbs up through icing, maximum climb or rated power at the best rate-of-climb airspeed is preferable.

When flying through sleet, the below freezing temperatures and high water density content are in the clouds above, from which the sleet is falling, so stay where you are.

When flying through freezing rain, the most dangerous icing condition known, the above freezing temperatures must be present in the clouds from which the rain is falling, so climb immediately to the warmer air.

When flying in cumulus clouds or mountain turbulence and encountering clear ice, climb to an altitude where the temperature is around −10° C. or lower, and ice probably will not form faster than de-icer equipment can handle it. If this same situation exists over water, and above freezing temperature exists at the surface, a better plan would be to descend. Terrain and surface temperature dictate whether to climb or to descend, in this situation.

When flying into wet snow, ice might be picked up, but colder temperatures exist above and the snow aloft presents no icing problem, so climb until hard snow is encountered. Remember, never take off in wet snow, as it may freeze before you can gain altitude.

To use de-icer boots properly, you must first understand their limitations and capabilities. Ice that does not cover two or more of the parallel tubes in the boot should be left alone. It will not be sufficient to cause serious consequences, and if the boots are turned on, only a part of the ice is likely to be broken loose. The chunks that remain not only destroy the airfoil more than the original formation, but act as a rough base for additional ice to adhere to and build up unevenly.

Since rime ice usually forms on the wing leading edge, the aerodynamic efficiency of the wing is not greatly impaired. And since it is granular in make-up, you stand a better chance of its breaking off in large chunks if you have greater masses breaking loose. The strength of your boots generally will handle considerable rime satisfactorily, providing not too much clear ice is mixed in with it to strengthen its cohesive qualities.

With clear ice forming on the wing, more care must be taken. Since it is highly tenacious, it must be broken off before it reaches a strength where the boot cannot expand. But if corrective action is taken too soon, the ice will merely crack along the line

between the inflated and deflated sections of the de-icer boot and will not be eliminated.

Experience has shown that about one-eighth of an inch to one-quarter of an inch is the correct thickness to begin boot operation. In clear ice it is better to begin de-icing too soon than too late. Once ice has formed thick enough to make your boot inoperative, you are at its mercy.

If either clear or rime ice are encountered for a short time only and it is certain that the aircraft will break out into clear air soon, the best procedure is to let it alone. Use your boots after you are through the icing zone to break off the majority of the ice and let evaporation clean up the rest of the wing for you.

Remove snow, frost, sleet and any other foreign particles that have frozen to the aircraft before any takeoff is attempted. Nothing short of an aerodynamically clean plane should be flown on a takeoff. Wing covers are available at any cold weather base, and ten minutes taken to put them on may mean hours saved trying to de-ice a plane.

If throttle ice is suspected, check movement of throttles before landing. You may want to go around and not have the power available for a pull-up.

Fly manually through icing, and move the control surfaces from time to time if the air is smooth to prevent them from freezing at the hinges and impairing their movement.

No matter what kind of ice is encountered or where on the plane it occurs, *gas consumption goes up.*

When warming up for takeoff, move the carburetor air controls to full hot on all engines to eliminate whatever ice has formed, and then return them to full cold for takeoff. Do not warm up where slush and moisture can be picked up by the props and thrown back over the wings and tail surfaces.

In landing with ice, make wide shallow turns, turn the wing-de-icers off, and *maintain plenty of airspeed.*

Beware of slippery runways with their resultant poor braking action. In short field landings with ice, only experience and keen judgment can dictate the slowest safe airspeed at which to cross the fence.

Today, many of our modern aircraft are equipped with thermal anti-icing systems, utilizing hot air and electricity. The trend is to provide hot air for anti-icing of flight surfaces, and electricity for anti-icing of propellers, radio masts and pitot assemblies.

Using the system may be accomplished in two ways: The heat may be applied after the icing starts because regardless of the amount and type of icing, heat will melt off the ice. The recommended method is to turn on the heat before entering an area of icing. The second method will lessen the amount of run-back of melted ice. It also eliminates the possibility of chunks of ice breaking loose, blowing back, and damaging the airplane.

In electric prop anti-icing, if you suddenly enter icing with very little warning, it is wise to use maximum heat for several minutes until the blades are well heated before returning to a lesser heat intensity.

One word of warning on electric prop anti-icing. *Never use prop heat on the ground.* Temperatures can become so high as to take the temper out of the blade. ●

Jet Engine Icing

Ice on fixed inlet screens and compressor guide vanes results in loss of thrust and temperature rise in jet aircraft.

BECAUSE OF BASIC DESIGN vagaries and certain facets of configuration, axial flow jet engines are more positively affected by icing than are centrifugal compressor power plants. Not that engine icing isn't an extremely important subject to *all* pilots!

The overall aspects of icing are covered elsewhere in this issue (see icing story, page 2). But because of the accelerated jet program, it is believed that engine icing of jet aircraft is of particular importance, and the instructions contained in T. O. No. 01-1-469 (29 June 1953), are spelled out here for the guidance of all pilots who fly jet aircraft.

It is generally conceded that heaviest icing usually takes place in clouds with strong vertical currents. Icing conditions in stratus clouds are usually light to moderate, but you *can* run into heavy ice in stratus, especially if your flight is of extended duration. Weathermen agree that the heaviest ice formation will generally be found at about −5° C.

Axial Flow Engines

In axial flow jet engines, ice forms on fixed inlet screens and on compressor inlet guide vanes. This tends to restrict the flow of inlet air, and the result is a loss of thrust plus a rapid rise in exhaust gas temperature (tailpipe temperature). As the air flow decreases, the fuel-air ratio increases, and the temperature of the gases going to the turbine is raised.

Attempts to raise engine RPM by fuel control increase only aggravates the condition, and should be avoided at all costs.

Ice build-up on inlet screens, heavy enough to cause turbine failure, can occur in less than 60 seconds when icing is severe. Even with the inlet screens removed, the air passage between the inlet guide vanes can be blocked in four minutes or less under extremely severe icing conditions. Current engines in this category include most models of the J-35, J-47, J-57 and J-65.

Wrong Idea

One idea that jet pilots should get out of their heads right now is that forcing heat by the use of ram pressure at high speeds will prevent icing. Nothing could be further from the truth. Not enough heat is generated at sub-sonic velocities to prevent the formation of ice. The rate of engine icing for any given atmospheric icing intensity, with outside air temperature below freezing, is relatively constant up to a true airspeed of 250 knots. Above 250 knots TAS, the rate of icing increases in ratio with the true airspeed. It is quite obvious, therefore, that reducing the airspeed to a safe minimum will reduce the rate of inlet icing.

Inlet duct icing can occur without the formation of ice on the fuselage and wing surfaces. When axial type jets fly at airspeeds below 250 knots TAS, with high power settings as in a climb, intake air is *sucked* into the engine compressor inlet, rather than *rammed*. This suction causes an air temperature decrease; and air at ambient above-freezing temperatures can easily be reduced to below-freezing as it enters the engine. The free moisture in the air is super-cooled, and causes engine icing, even though there is no external evidence of icing conditions.

The maximum safe temperature drop that can occur on most axial-flow engines is 5° C. The greatest temperature drop is found when the airplane is being run on the ground at high RPM.

Centrifugal Types

Centrifugal compressor type jet engines are relatively free from icing difficulties. Engines in this category are the J-33 and J-48. While it has been possible to ice the J-33, icing conditions must be extremely severe.

The J-33 engine has also been known to ice up on the ground in some airplanes.

Pilots should learn to recognize jet engine icing by any increase in tailpipe temperature. This is usually the only indication before the mill quits cold. If you do get a tailpipe rise, and weather conditions are ripe for icing, learn the recommended procedures outlined in the Dash-One.

In the first place, learn to avoid atmospheric icing conditions whenever possible. This is predicated on careful flight planning, and close coordination with the weather people.

If the ambient temperature is in the approximate range of 0° C. to 5° C. and the atmosphere is moist, the speed of the airplane should be held to 250 knots TAS. If actual icing is encountered to a point where it is visible on the outside of the airplane, the airspeed should be reduced, the altitude should be changed immediately by climbing or descending, the heading should be changed to avoid all possible cloud formations and a close check made on the tailpipe temperature. Engine RPM should be reduced to a point where tailpipe temperature can be kept at a safe maximum.

Jet engines protected by anti-icing systems and retractable inlet screens are not susceptible to icing hazards. However, on such engines, screens should be retracted prior to takeoff when potential icing conditions exist. ●

Portrait of a pilot on final approach. Research flight movies determine for each frame just where pilot is looking.

Your Point of VIEW

Keep your eyes open and your head on a swivel —you are not alone when you're cruising in the blue

Means for making that other airplane easier to see, both in daytime and at night, are the subject of extensive and continuing investigation. Various methods for improving the airplane's visibility under all conditions are being tested both by the USAF and Civil Aeronautics Administration.

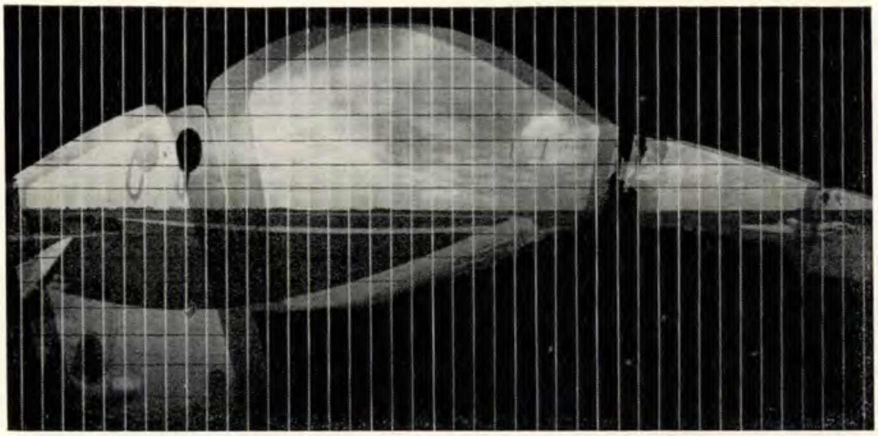
YOURS is not always the only airplane in the wild blue yonder. Sometimes there is another one, and sometimes it is heading your way. It is always nice to see it in time to avoid a collision. The question of "how you look at it" is important. The windshield and windows must be big enough. How far up and down should the pilot be able to look? How far to the left and to the right? What about distortion? Can we make that other airplane more conspicuous, easy to see?

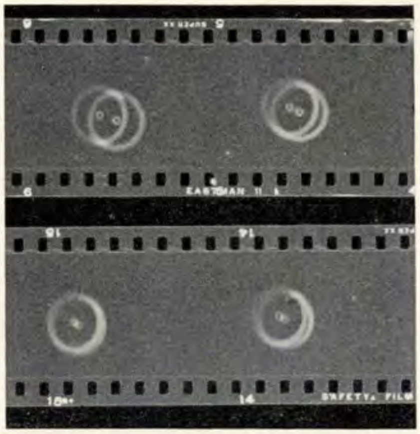
The answers to those questions are emerging from a program of study and testing now in progress at the Civil Aeronautics Administration Technical Development and Evaluation Center at Indianapolis, Indiana.

This is not a quickie; there are a number of "swinging doors." For example, the cockpit can not be all glass. What about instruments, controls and other essentials in the cockpit? There is the matter of sun glare. How much vision can the pilot use? Will high intensity lights be effective in daylight? How about the electrical power required to operate them? We must be practical.

The answer to the cockpit vision problem is being furnished through several fixes. An analysis of pilots' opinions has obtained one fix. Measurements of where they look while flying have obtained a second. Recently completed flight path measurements and studies have determined relative angles of vision between two airplanes for any combination of flight paths that would lead to a collision. A flight program soon to be started will determine what angles of vision the human machine is able to use.

Pilots' opinions were obtained





Panorama, above, measures extent of pilot's vision from C-47 cockpit in terms of angles. The groups of circles measure waviness of windshield, as indicated by their displacement.

through the use of a carefully prepared questionnaire so worded that a numerical evaluation of their thinking was obtained. Some 1500 of these, involving eight transport aircraft models, were analyzed. This required accurate measurements of the vision angles provided by the particular aircraft models involved.

To obtain such measurements a camera-mounting arrangement was developed. This, in effect, is a swivel-necked robot that sits in the pilot's seat and photographs the windshield and windows from the pilot's eye position as it rotates through 360°. It has two lenses that look around posts as do the pilot's eyes.

Double Exposure

The resulting picture is a deliberate double exposure, but it is a true measurement of the effective angles of vision and post widths as would be seen by the pilot using both eyes (binocular vision). The vision angles at all points along the edges of the windows and windshield can be determined immediately, since the angle grid lines are a part of the picture.

These eye motion records during flight were obtained in the Boeing Strato-cruiser through the courtesy of Pan American and United Airlines. This airplane model was chosen because it provides greater angles of vision than any other transport.

Before each flight, photographs were taken of the pilot's eyes as he looked steadily at various fixed points around the windshield. When these reference photographs were compared with the motion pictures taken during flight, it was possible to determine, frame by frame and within 10 degrees, where the pilot was looking.

Some 30,000 frames were individually analyzed by two independent readers. The photos involved 14 pilots while taxiing, taking off, climbing, approaching and landing.

The analysis of those measurements also determined optimum window and windshield contours. These corresponded closely with the contours as determined by the pilot questionnaire study.

Investigations of devices that provide vision beyond that provided by the windshield and windows include rear view mirrors, very large wide angle (180°) lenses, and other devices. The rear view mirror has proved successful, particularly on small personal type airplanes. The wide angle lenses have certain drawbacks such as reduction in image size and a distortion of the apparent speed of an approaching aircraft. However, this study is continuing.

Windshield or window distortions appear wherever the opposite surfaces of the glass are out of parallel (wedginess). This causes a bending or deviation in the line of sight. Variations in wedginess produce a wavy effect.

The distortion measuring instrument projects a very small circle of light onto the windshield and photographs its reflections that are returned from the front and rear surfaces. If the two reflections coincide as one circle, that portion of the windshield is true. If they are displaced, the amount of displacement measures the amount of deviation in the line of sight. The instrument will detect a deviation of 0.012 degrees. This would cause an object a mile away to appear to be displaced only one foot.

Very clear daylight conditions are considered the most hazardous as concern presently equipped aircraft. The visible contrast between the airplane and the bright sky background is very poor. The traffic density is higher and, last but not least, the pilot tends to relax, to become less alert. This urgent situation is receiving high priority attention.

The night time hazard is also urgent. The conventional low intensity flashing lights are becoming less and less adequate as speeds and traffic densities increase. It appears that these should be supplemented by high intensity anti-collision lights. Various types of H. I. units are coming into use. The Center is not developing lighting units as such, but rather is devoting its efforts to the obtaining of basic numerical data that will aid in the establishment of requirements for external aircraft lighting. These involve the measurement of pilot reactions to various colors, intensities, flashing frequencies and configurations. These are now being measured in the laboratory under simulated flight conditions. Similar measurements are to be made in flight.

The avoidance of air collisions depends upon many factors. The most important is the ability to see that other airplane early. Regardless of other variables, if you can't see the other aircraft steaming up on collision course, it's going to be difficult to duck!

This study of better vision continues to be a weighty problem and isn't licked yet. But in the meantime the only logical solution must rest with you. Keep your eyes open and your neck on a swivel. ●

how to check an *Engine!*

Back in August of 1951 we devoted five pages to engine check procedures. Since that time we have had numerous requests for a re-run of the article. If we may utilize comments from the field as a yardstick, it is most apparent that both pilots and maintenance personnel have benefited greatly from the original article.

BASICALLY, the following SOP was developed for C-47's and all figures quoted apply to that aircraft. With minor revisions, however, the procedures given can be made applicable to practically any reciprocating engine.

(Before starting, note the manifold pressure reading with the engines at rest. This setting will be used in accomplishing certain checks later.)

Start the engines as specified in T. O.'s 01-40ND-1 and 01-40NC-1. With adequate electrical power it is preferred to turn the engine with the starter for two complete revolutions before turning on the ignition switch and priming. This procedure will provide an extra safety factor against hydraulic lock in cold weather as all intake valves will have been actuated before the engine fires. This assures protection from any liquid which may have been trapped in the intake pipes from where it could be drawn into the cylinders. After the engine starts, move mixture control from the IDLE CUT OFF to the AUTO RICH position and continue priming if required.

In cold weather, the carburetor heat control may be moved to FULL HOT position as soon as the engine starts firing. This will aid in vaporization of fuel and prevent over-loading cylinders with liquid fuel. Use carburetor heat as required during all ground operation to stay within the 15° to 40° C. range. Operation above 40° C. may result in detonation.

Preflight Checks

Throttles should be set to provide 1,700 RPM for exercising props and other preflighting where applicable. Props should be exercised four or more times to insure complete warming of prop oil and scavenging of diluted oil out of the governor system, so there will be no possibility of the governor losing control during takeoff.

If the takeoff is delayed for an extended period of time, the props should be exercised again. If the feathering button will not reduce the RPM on the first attempt, pull the button out and depress it again. Do not allow the button to remain in over 90 seconds, as damage can result to the feathering motor.

A power check should be made using the same MP as that which the manifold pressure gage showed when the engine was at rest before starting (this is field barometric or pre-start MP). The propeller governor control should be in the HIGH RPM position and the carburetor pre-heat control in FULL COLD. Unless there is some engine malfunction this will give the same RPM, ±50 RPM, on a given engine and propeller combination regardless of the outside air temperature, field elevation or field barometric reading.

Tap the instrument lightly during the power check to eliminate instrument sticking errors. Normally, the RPM obtained in the C-47 will be approximately 2,450, but this may vary with some airplanes because of a variation in the type of propeller used or the propeller low pitch stop setting. A headwind will cause a higher RPM than normal. While making the power check, note the engine instrument readings to make certain they are within the limits shown on the instrument face.

Make the ignition check at the field barometric MP just after the power check, with the prop governor still in the HIGH RPM position. Use AUTO RICH mixture position. Allowable engine drop is 65 RPM. Tap the tachometer lightly during the ignition check to eliminate instrument sticking errors. Allow four or more seconds at each single mag position. Record both the fast (or initial) and the total mag drops. Watch the engine for roughness in addition to recording the RPM drop.

It is permissible, but not a requirement, to make a 2,700 RPM run-up to 45″ MP in order to check propeller governing and smooth engine operation at this high power condition. It is important to understand, however, that this does not constitute a power check because the propeller is not riding on the mechanical low pitch stop. This check merely indicates that the governor is functioning properly and the engine is operating smoothly, as determined by watching for engine roughness from the cockpit window.

This high power condition should

be held only a few seconds as it has a detrimental effect on engine life. It is pointed out that this type of check is not made by the commercial airlines because the power check outlined above is considered sufficient for their operation. Propeller governing at takeoff RPM can be checked adequately during the first part of the takeoff run. In general, high power ground operation at 2,700 RPM should be discouraged.

For military operation under certain circumstances such as icy runways, night takeoffs in unfavorable weather conditions, the first flight that an airplane has made in several days or after considerable maintenance has been performed on the airplane, a high RPM runup can be justified. It is not necessary, however, to make such a runup before each leg of a multi-leg trip during the same day. For such a trip, numerous high power runups are apt to make the flights less safe rather than safer because of the accumulation of high power operating time on the engine.

A postflight check before the engines are stopped after the last flight of the day is outlined in T. O. 02-A-1-29.

A runup on the taxi strip is not a bad idea as taxiing at low RPM back to the apron will cause oil and cylinder head temperatures to drop low enough to accomplish suitable oil dilution if required.

Make a power check by running the engines up to field barometric MP with the propeller set in the high RPM position. This should give the same RPM as in the preflight power check, plus or minus 50 RPM, unless there is some engine malfunction. You can obtain the MP gage reading for field barometric manifold pressure even though the engines are running, by momentarily opening the MP gage drain valve and observing the gage reading while the valve is open.

Check the mags at field barometric MP. Use the same procedure as for the preflight check.

Set the RPM at 1700 and move mixture control from AUTO-RICH to AUTO-LEAN and record RPM and MP change. An increase of over 25 RPM or a decrease of more than 75 RPM as a result of the mixture change indicates an excessively rich or lean carburetor.

Pull throttles back to the idle stop and record idle RPM. After the engine speed has stabilized, move the mixture control slowly toward IDLE CUT-OFF and note change in RPM and MP. An increase of more than 10 RPM or a decrease of more than 1/4" MP indicates an excessively rich mixture.

When the RPM drops to 300, return the mixture control to AUTO RICH position.

With the mixture in AUTO-RICH, check acceleration and deceleration of engines.

At 600-700 RPM, make an ignition switch check by momentarily turning the switch to the OFF position and then back to BOTH.

In cold weather operations, proper oil dilution is the main factor in being able to start aircraft engines for the next mission. The table on the cockpit check sheet should be used to accomplish this dilution. Oil dilution should not be accomplished with an oil temperature above 50° C. To obtain satisfactory dilution, if the oil temperature is above 50° C., shut down the engine and allow oil to cool to below 40° C., then restart and dilute.

Hydraulic Lock

Hydraulic lock is caused by the piston contacting a combustion chamber full of liquid fuel or oil. It is not likely to cause damage, provided the engine is being turned by the starter only and has not fired at the time the lock occurs. However, if the engine fires and experiences sudden stoppage, due to the piston striking the liquid, damage is quite likely to occur.

Rotation of the engine for six blades or two propeller revolutions before priming and turning the ignition switch ON gives reasonable assurance that all the combustion chambers are clear. In the event hydraulic lock is experienced while cranking the engine with the starter before the engine has fired, the lower spark plugs should be removed and the fuel or oil allowed to drain out.

Pulling the engine through backward will not satisfactorily eliminate the lock as the liquid will be pushed into the intake pipes.

Hydraulic lock resulting in sudden stoppage after one or more cylinders have fired is just cause for engine removal.

Power Check

A pilot will sometimes make a "power check" consisting of a part throttle runup to near takeoff manifold pressure. By doing this he secures an intuitive assurance of power output without running the engine long enough at a stabilized setting to achieve an interpretable relationship between RPM and MP.

If he does run the engines to a stabilized setting, he usually does so in an attempt to check one engine against another. This constitutes a poor basis for judgment in that both engines may be in equally poor condition. Running the engine to a part throttle, high power, setting only assures that the engine may be expected to attain the same relationship again —but does not necessarily measure its mechanical condition or horsepower output reliability.

Any standard engine propeller installation in good condition, started, warmed up, and run in full low pitch up to a manifold pressure equivalent to atmospheric (pre-start MP) for the operating field elevation will attain a given RPM or "norm" from day to day and time to time. This is true, providing the carburetor pre-heat control is in the FULL COLD position. Any resulting RPM lower than the norm is a proportional measure of horsepower loss. This constitutes an accurate power check.

It is anticipated the average pilot will detect an apparent fallacy in this recommended power-check system by pointing to the fact that as inducted air temperatures vary with summer and winter, horsepower output will vary at atmospheric manifold pressure. This will upset the validity of the proposed procedure since barometric pressure varies from day to day and because of possible inaccuracies in manifold pressure instruments. Fortunately, all these factors are self-compensating. That is, the lower free air temperatures of cold days which boost horsepower also boost drag properties of the propeller turning in denser air.

The same self-correction is evident in barometric changes from day to day which equally affect air density inducted by the engine (at atmospheric MP) and propeller drag. Variations in field elevations at which the check is performed will be equally self-compensating.

The effect of wind cannot be accurately accounted for in any type of ground power check without using special equipment. A power check made with the airplane headed into the wind will result in a higher RPM than normal. An engine should never be run up with a tailwind because of the detrimental effect on engine cooling. A headwind or crosswind should never result in a low RPM reading during a power check and therefore the wind effect should not be confused with any malfunction which would result in an RPM loss.

The curve on Fig. 1 shows the variation of RPM with horsepower (or MP) while the engine is being operated with the propeller governor control in the FULL INCREASE RPM or TAKEOFF position.

From a relative low power represented by point "A" to the point where the propeller starts to govern at 2,700 RPM as indicated by point "B", the RPM increases with an increase in manifold pressure or horsepower (HP). This portion of the curve between "A" and "B" is known as a "Propeller Load Curve" because the propeller is in a fixed pitch against the mechanical low pitch stop causing the RPM to vary as an exact function of power. After point "B" is reached, a further increase in MP (or HP) no longer results in an increase in RPM because the propeller governor increases the propeller pitch to hold a constant 2,700 RPM.

Therefore, any determination of power as a function of RPM cannot be made in the 2,700 RPM portion of the curve from "B" to "C". It must be made in the "propeller load" portion of the curve from "A" to "B". A power check at prestart MP falls well within the portion of the curve between "A" and "B". Engine operation at 40" MP (or any other high MP resulting in governing at 2,700 RPM) does not constitute a power check.

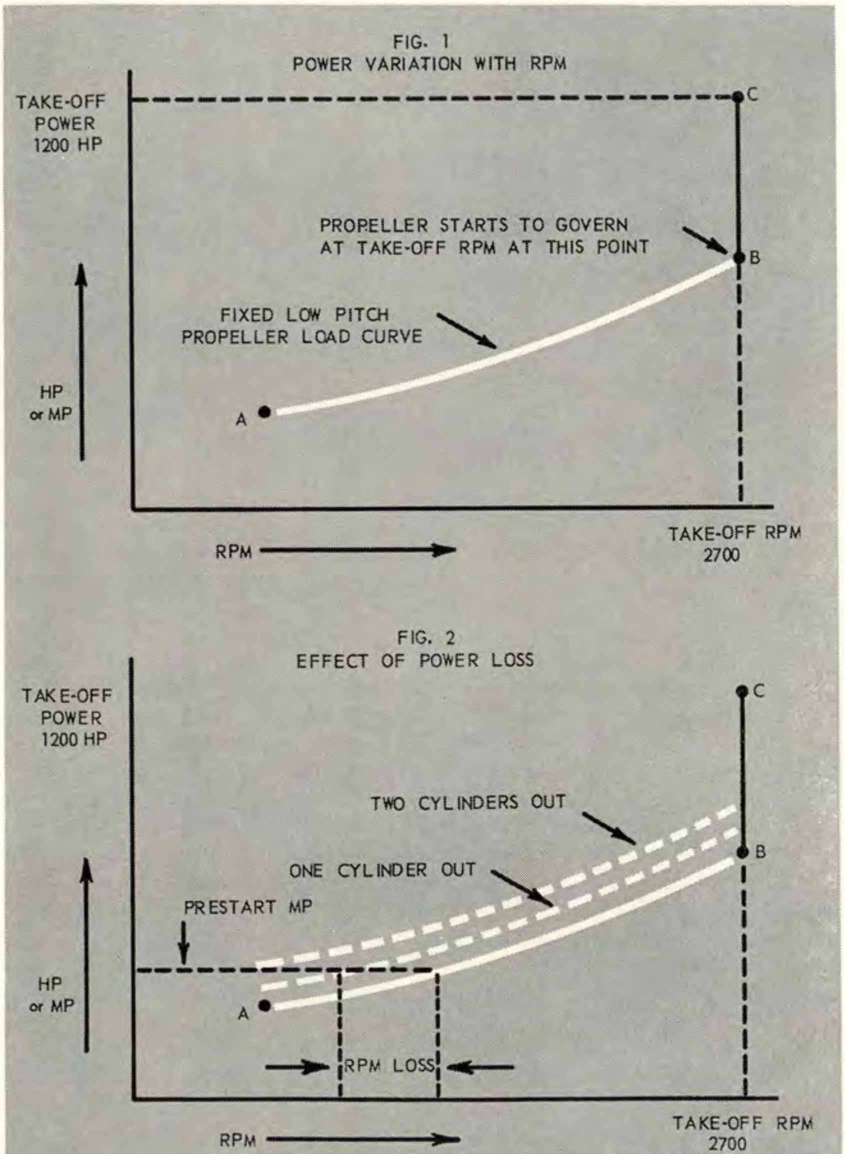


Figure 2 shows how a higher manifold pressure is required throughout the whole "propeller load" range to obtain a given RPM if one or more cylinders are not firing.

A partial loss of power from several cylinders, because of loss of compression or for any other reason, would show up in a similar manner but no power loss would be evident once "takeoff" RPM was reached. In other words, when operating at 2,700 RPM which is the takeoff RPM for the C-47 airplane equipped with R-1830 engines, it would not be possible to tell whether 40" MP was giving 1,000 HP or 800 HP.

The 200 HP difference would result in a different propeller pitch setting as provided by the governor but there would be no difference in the instrument readings as long as the propeller was governing at 2,700 RPM. Again, operation of the engine in the takeoff RPM range does not provide a true power check.

One of the basic fallacies evidenced from time to time is the belief that a standard mag check with RPM drop within tolerances is an accurate measure of overall engine dependability. RPM drop alone is not a reliable criterion.

A satisfactory ignition check must show that the engine is operating smoothly in the single mag position as well as show that RPM drop is within allowable limits.

For these reasons a more thorough mag check procedure is suggested, employing standard techniques. Time at each single mag position should be at least four seconds with special attention devoted to estimating fast or initial drop as well as the total drop.

The fast or initial RPM drop is generally indicative of the condition of the spark plugs and ignition harness.

The slow RPM drop following the fast drop indicates possible inaccuracy in distributor finger or magneto timing. This sensitive mag check, if properly employed in combination with an accurate power check, will give an accurate indication of engine condition. ●

FICKLE FATHER TIME

Keeping polar time can be a complicated task for pilots and navigators who fly over or around the North Pole.

By Lt. Robert C. Johnson

A FAVORITE QUESTION of aircrews flying over the North Pole is, "What time is it?"

This question always gives rise to debate because it is possible by flying a tight circle around the Pole itself, to fly through a twenty-four-hour time period in a few minutes. If, when one arrives there, for example, the sun happens to be over the 90th Meridian which runs through Memphis, Tenn., then in Memphis it is noon, and while we are approaching the Pole in that meridian, we're in that same time zone and it is noon for us, too.

But simply by turning 90 degrees to the left we can be on the Greenwich Meridian where it is six o'clock in the evening. Continuing left we pass meridians rapidly which, like spokes, radiate outward from the hub of a wheel. Every 15 degrees it grows an hour later and the second quarter turn takes us past midnight. Then we're over the International Date Line where it is six o'clock in the morning of *the following day!*

Another half minute of turn at the same rate brings us back to 90 degrees at 12:02 Memphis time for a sort of world's record—around the world in two minutes! Or, suppose that instead of circling, we fly straight across the Pole itself, from Memphis meridian to 90 degrees E—incidentally, flying from, say, Friday to Saturday. Then in a few seconds and without turning the airplane a hair, it is no longer noon in the new time zone, but midnight.

All of this led me to rap my knuckles sharply against my forehead on my first flight or two and mutter, "Just what the heck time is it here, anyway?" But after some head-scratching, I came up with an answer which, although it may never rank with the Theory of Relativity, is quite satisfactory to me. I shall be gravely disappointed if no one ever asks me what time it is at the North Pole right now, for I look forward to the expression on his face when I ignore my watch and judiciously consult the nearest calendar.

Ides of March

If the date should happen to be the fateful Ides of March, I'd answer: "Why, six o'clock in the morning, sir;" while on the 4th of July I would reply: "Oh, a few minutes after noon." And so it is.

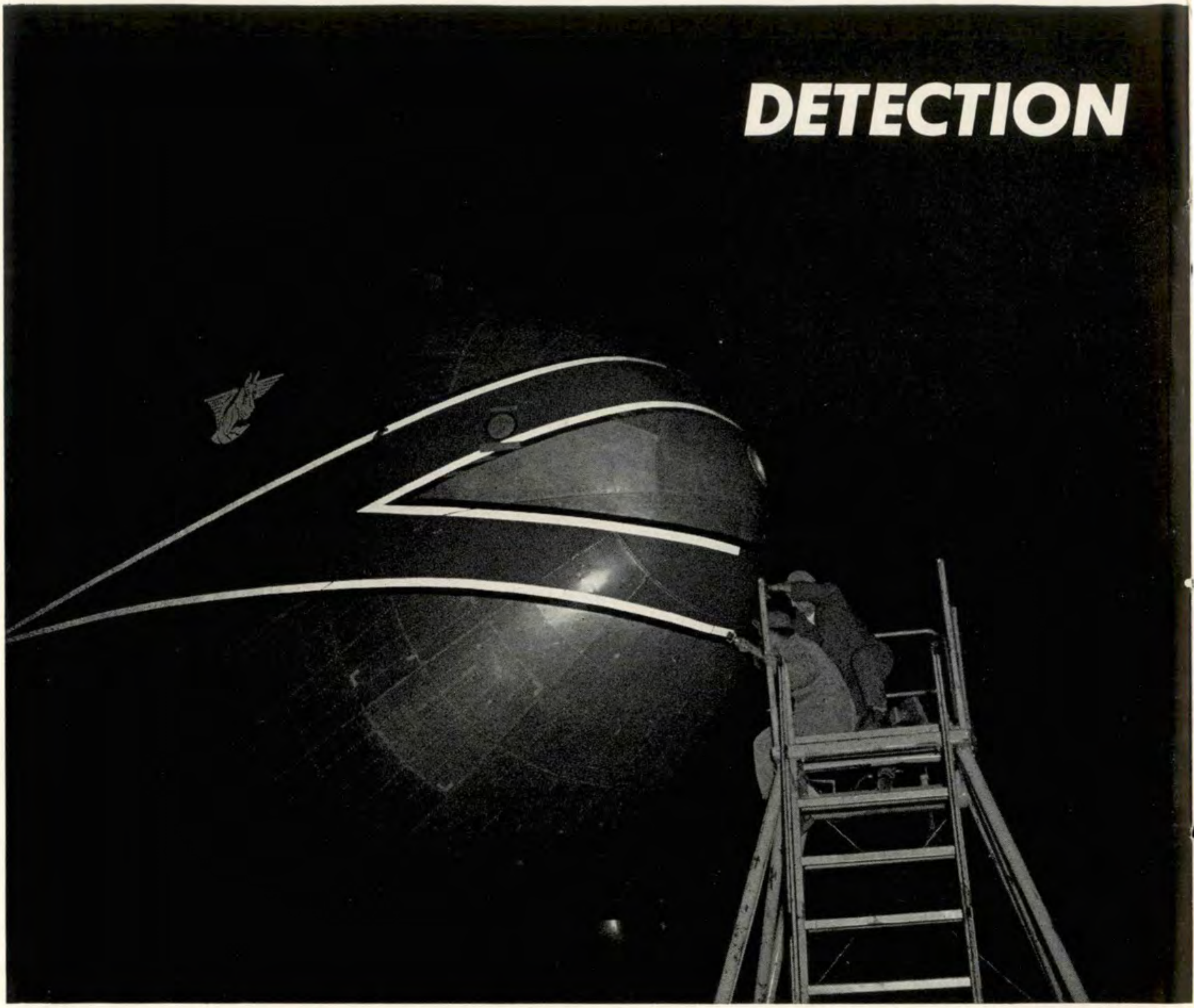
In March the sun hangs just below the horizon and gives a wide band of twilight. It is actually just before sunup there—for about a month. And on the 4th of July, having climbed to the monumental elevation of 23.5 degrees on the 21st of June, it has begun to slip downward a little, and so no matter how many jewels are in your watch, which at the moment is pointing straight at 8:20 P.M. or some such hour, at the Pole on July 4th, doggone it, it's a little past noon —or is it?

Or, should this not be too clear, consider a plane as it flies its weather run from Eielson AFB. Leaving the Eielson runway at 1500 hours of a certain day, the aircraft arrives at the International Date Line shortly after passing Nome, some four hours after takeoff. This, of course, puts it into tomorrow. From then on, today's mission flies along tomorrow, going on to a point past Attu, at the end of the Aleutian Chain. There it turns around and returns along a more southerly route, flying back toward today.

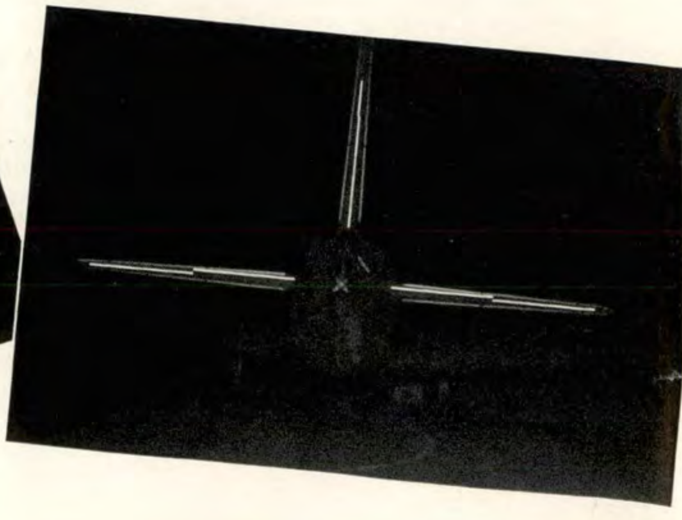
Approximately 10 hours after its original takeoff, it arrives at the International Date Line again and theoretically flies back into yesterday, if you consider the day they had been flying in all the time as "today." However, another complication sets in at that point. Ten hours after a 1500 takeoff would naturally put them at 0100 the next morning, or in tomorrow, even though you figure it on the "today" side of the Date Line. Therefore, upon crossing the Line, the puzzled crew finds that yesterday has gone into the limbo of history, to be replaced by today, which was tomorrow yesterday.

The astounding fact then comes to light—they had been flying in the day after tomorrow all the time and never even knew it! ●

DETECTION



Crew chief fits band of reflective tape around the nose of a C-124. Material is self adhesive and flight tests prove that it will stand up better than paint. Lower photos: Taxiing aircraft are able to judge wing clearance and reflectors give reference point.



through REFLECTION

By Major W. H. Maxwell, Flying Safety Officer
and Capt. Keith G. Robison, 4th Troop Carrier Squadron,
Larson AFB, Washington

THE night is as black as the inside of McCarty's coal scuttle. You are a vehicle driver; behind you in the carry-all is the crew of a 4th Troop Carrier Squadron C-124. You start for the parking area and the aircraft commander tells you, "my airplane is zero-nine-six." But to you, all cats are gray in the dark and the huge hulks all look alike in the blackness of the ramp.

Suddenly the aircraft commander flicks his flashlight ahead and to the right. There's a square of silver light, and staring you in the face, right on the nosewheel door, are the numbers "096." Looks like neon, it's so bright, but actually it's a scotch-lite reflective sign. In a matter of seconds you deliver the crew and start back to Operations. No milling around the area, driving within a few feet of each airplane to squint at numbers.

★ ★ ★

You are an aircraft commander, going carefully through your preflight checklist. In the cockpit, the trim tab indicator says NEUTRAL. Controls are free and easy. Your scanner is in the tail position checking with you on interphone and calling out the actual position of the tail surfaces. As the rudder swings right to left, a bright patch shows up when the rudder is in full travel position. As the trim-tab is rolled up and down, another patch of silver glows in the dark. The scanners' flashlights pick up the small squares of reflective tape at these critical points. If you can see the silver tape reflecting, your controls are free, because they show up only when the control surface moves to full position. Because the C-124 is "flown primarily with the trim tabs," this check is extremely important.

★ ★ ★

You are making your first trip at night in the left-hand seat. Cripes, how glad you are to get out of the "idiot's corner." Sitting next to you is the IP, and you know he's watching every move you make. So maybe you *are* a little jumpy . . . just a *very* slight case of "check-itis."

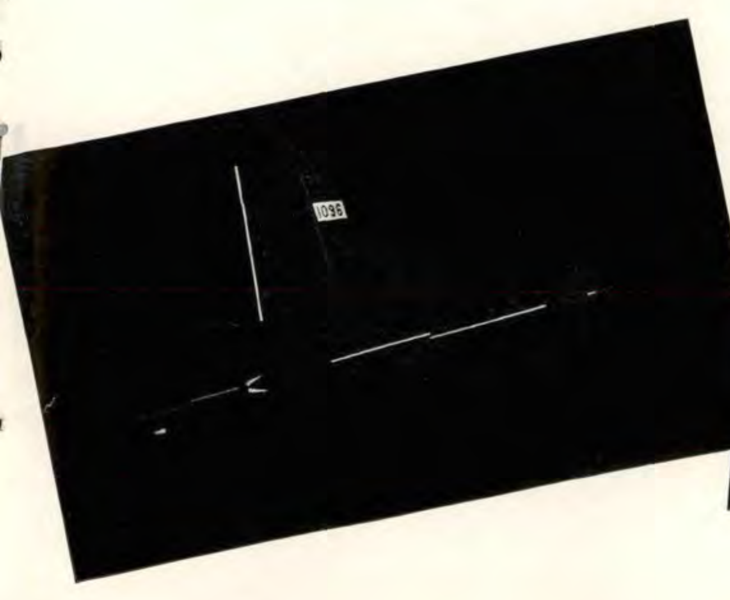
The ramp is crowded. On each side of the parking strip long lines of airplanes loom silently in the night. Even with the aircraft parked exactly on their parking spots you know that you are going to be close, but how close?

But when you taxi out, it's "negative perspiration" . . . for each parked airplane is striped, nose and wingtip, with reflective tape. You know every minute how much clearance you have. The heater pods of those C-124's stand right out in the night. Each pod has a cone of silver reflective tape wrapped around the aft section, and a four-inch band of silver around the forward section. The two are joined by a horizontal four-inch strip.

The nose section of each airplane is striped by curving horizontal strips of reflective tape, in the color of the respective squadron. Looking like whale-mouths on the noses of the C-124's, these strips warn against taxi collision, and serve as squadron identification markings.

Further development of the wingtip markings, probably stripes of reflective tape inboard of the wingtips on the top surface of the wing itself, are intended to serve as reference points for formation flying. By having a wingtip light deflector shine a beam along these wing strips, pilots flying "in the slot" can tuck in closely in night formation and have a good margin of safety. Because of the angle of deflection of the scotchlite tape, only the man in formation can see the reflection. If he is three degrees from "dead-on," the reflection ceases. Because of this factor, the reflection is

Col. Richard Jones, Commander of the 62nd Troop Carrier Group (H), gets briefing by Lt. Col Jerome M. Triolo, commanding 4th Troop Carrier Squadron, on fine art of taping up wheel door. (Night Photo)



not readily visible to enemy observers.

Conversely, the reflective markings make identification by friendly aircraft easier. With the tape causing tail numbers to shine like a good deed in the night, interceptors need not fly dangerously close to any transport in order to identify it. With reflective tape on the tail numbers, a flick of the landing lights from a quarter-mile away will offer ready and positive identification.

An additional job of reflective marking is acceleration of troop marshalling when large numbers of personnel are to be loaded at night. The wing and gear-door numbers, reflectively taped, eliminate the necessity of airlift personnel hunting up and down the line to find the proper airplane. Loading time is reduced materially, to say nothing of reducing the accident potential of personnel carriers cruising up and down the loading ramp.

Where was this simple and inexpensive idea born? Why, up in the Moses Lake country, where the 62nd Troop Carrier Group (H), hang their hats. It seems that one night, after a black-out scramble that was slightly confused, it was apparent that some means of identifying airplanes in the dark was definitely required. Lt. Col. Jerome M. Triolo, commander of the 4th Troop Carrier Squadron (H), spearheaded the reflective tape idea, which has all the earmarks of growing into a real dollar-saving operation for the Air Force. Triolo, gathering his people around him, said: "Why not illuminate the strategic parts of the airplanes with reflective tape?"

Before the sun set that day, a C-124 was striped along the nose section, wingtip heaters and tail cone. Exhaustive tests were made with flashlights, aldis lamps and aircraft taxilights, and each method of lighting lit up the extremities of the airplane with amazing brilliance.

It was found that an aldis lamp or flashlight illuminates the serial number of an aircraft covered with reflected tape from a distance of 200 yards. By using silver tape, a reflection 220 times that of an ordinary white painted surface or the ordinary silver surface of the aircraft fuselage, is effected. Other reflection values for variously colored tapes are:

Yellow: 75 times brighter than white painted surface.

Red: 60 times greater than white painted surface.

Green: 30 times brighter than white painted surface.

Gold: 140 times brighter than white painted surface.

The question has been raised, "How long will this stuff stick on an airplane?" The 4th Squadron has one C-124 with more than 100 flight hours on the reflective tape. The nose paint has peeled off, but not the tape. The reflective tape is rainproof and windproof. It reflects in weather, under clear ice, and under water. Frost will not adhere to it. Even in inclement weather it can be seen from one mile out, or from 5000 feet altitude.

Outboard strip of reflective tape and cone of tape about trailing tip of heater pod serves two purposes.

The cost factor involved is extremely interesting. Total cost of illuminating a C-124 (and a C-124 takes a lotta huggin' and a 'chalkin'), is less than forty dollars. It takes about 20 man-hours to install the reflective tape. Balance these figures against the cost of one wingtip heater assembly plus 80 man-hours for installation and see what a fine saving has been offered Mr. Taxpayer.

High-ranking commanders who have seen the reflective tape experiment are favorable in their reaction. General John K. Cannon, Commander, Tactical Air Force; and Major General Robert W. Douglass, Commander, 18th Air Force, have encouraged further experimentation. Brigadier General H. W. Bowman, Commander of the Troop Carrier Wing at Larson AFB, has enthusiastically backed the program. Colonel Richard Jones, commanding the 62nd Troop Carrier Group (H), has been interested to the point where he has actually supervised many of the experimental applications.

In addition to the use of reflective tape for aircraft markings, Lt. Col. Triolo has some very progressive ideas on airstrip lighting. Based upon his experiences in Korea, Triolo feels that runway lights and other airfield markings can adopt the reflective tape idea. He feels that by using reflective markings on forward airstrips, man-hour expenditures on lighting maintenance would be eliminated.

Says Triolo: "By covering an inverted cone the size of a Number Ten can with scotchlite and placing it on a stake to raise it above the ground, you have a marker every bit as brilliant as a light of comparable size. In fact, all electrical airfield lighting equipment could be eliminated for forward landing strips, without sacrificing one iota of the safety factor. Even drop zones and landing zones could be outlined with reflective markers by pathfinder teams, quickly and positively."

The safety-conscious personnel of the 4th Squadron feel that the reflective tape idea is good enough to be passed on to other units in the USAF. They say it pays off big in dollar savings and makes it easier on the men who do the flying. ●

when you're crowded in the cockpit use a . . .

FLIGHT RANGE GUIDE

IF YOU'VE EVER SAT in a fighter cockpit, stick between your knees, trying to change your flight plan with the aid of a dog-eared, well-thumbed handbook, you will appreciate this information on assistance currently available through your normal supply channels.

Engineers at Wright Air Development Center have come up with a scheme that presents the data you need, neatly laid out and requiring minimum effort on your part. They've printed on laminated vinylite plastic cards all the cruise control data found in the Handbook of Flight Operating Instructions. These cards slip into a plastic holder which "windows-out" the applicable data.

The whole thing goes into a canvas wallet-type case small enough (5" x 7") to be carried in the pocket of your flying suit for easy reference during flight. This gadget, called the Flight Range Guide, contains all the data necessary for you to plan your mission and is compact enough to be invaluable for in-flight operation.

Each set contains data cards which give the available range and the operating instructions at eight different altitudes for various airplane configurations and weights. Data are included for all combinations of weight and altitude normally encountered during flight. The reverse side of the card contains climb and descent charts for the weight and external load noted on the face of the card. If you're flying a multi-engine airplane, you'll find reduced power engine data there, too.

To use these cards in obtaining range and operating information, the pilot simply selects the appropriate card, inserts it in the holder, aligns his desired altitude in the "altitude window" and reads the desired data directly below. Simple instructions are printed on the holder, although to get the most use out of the data it is suggested that you get pretty well acquainted with the introduction to the Appendix I "Cruise Control" Section of your Flight Handbook.

Extra Cards

Auxiliary cards, not designed for use in the holder, contain data for takeoff, combat, landing, airspeed calibration, etc.

For instance, if you're flying a plane like the F-84F, you'll find that the stack of cards is pretty thick—61 cards, to be exact! This isn't done to load you down, but just to cover adequately all the different combinations of external items — bombs, tanks, rockets. For any given flight, weed out the ones that are not applicable to that particular flight and you'll have to carry only a half dozen or so.

In addition to other advantages, the cards are durable, washable and very legible. There's even an area on the holder which provides a suitable writing surface for any necessary calculations.

These Flight Range Guides are available in stock for every jet fighter currently in service use by the Air Force and for a couple of light jet bombers.

How do you get them? Simple. The cards are contained in the Technical Order system. Their identification number is simply the flight handbook number with the letters "FR" replacing the "TO." For example: FR01-15FDC-1 is the F-89C Flight Range Guide.

Have your Base Air Inspector order them the same way he orders your T. O.'s. Once you're on the list, you'll receive automatic distribution for all revisions. The holders and cases are in supply class 05A and are available through normal supply channels.

Any comment or complaint on the Flight Range Guide or the Flight Handbook, such as use, distribution or the data included, should be forwarded to the Commander, Wright Air Development Center, Attention: WCOSF (Flight Data Branch), Wright-Patterson AFB, Ohio. ●

some like it COLD!

By Deric O'Bryan, Ph.D., Chief, Arctic Section, ADTIC, Maxwell AFB, Ala.

Dr. O'Bryan has traveled extensively in Finland, Alaska, and in the Canadian Arctic, and is the author of various articles on anthropology, survival and arctic survival. He was a member of the Bob Bartlett Arctic Expedition, 1927; leader of the Mill Island Expedition, 1951, and an official observer on "Exercise Warm Wind," 1952.

SURVIVAL is living on the means available under emergency conditions.

In the Arctic this is a tough assignment, as the means available are few and far between. But it can be done. The first step is to analyze the dominant characteristics of the Arctic. This knowledge is the basis of preparedness for survival in the world's largest icebox. From then on, with all the survival techniques and equipment available, the harsh implications of survival are lessened. After all, the Arctic is home to thousands of Eskimo, Norwegians, Finns, Lapps, Samoyeds, Yakuts, Chukchi and to tens of thousands of Russians.

Each person who uses the term has a different concept of the Arctic. Airmen may remember it as a paradise for hunting and fishing, or as a cold hell. An engineer may think of it as the region of permanently frozen ground, the permafrost zone. A physicist is reminded of intense magnetic disturbances and auroras. An astronomer visualizes the polar area where the midnight sun is visible at least one day each year. A botanist pictures the lands north of the limits of tree growth.

However, most meteorologists and geographers think of the Arctic as "the region where the average temperature of the warmest month is less than 50° Fahrenheit." This condition is in general acceptance and is used by our Department of Defense as the basis for a definition of the Arctic.

The airplane has consistently lessened the remoteness of the Arctic since the 1920's. In this day of great circle routes, civilian and military craft alike fly over the Arctic. The polar regions have become increasingly important to our Air Force, reflecting the precept that a military organization must recognize potential enemies and plan accordingly. Most of the short-flight routes between the

Far Northern traveling and camping are for those who like it cold. The camp at right needs some snowbank windbreakers around the tents.

United States and the Soviet Union pass over polar regions. Quite properly most military operations and the command responsibility for Arctic regions are the concern of our Air Force.

Arctic Characteristics

Cold, isolation and seasonal extremes of daylight and darkness are all dominant characteristics of Arctic environment. These conditions prevail far south into sub-Arctic areas; in fact, temperatures there range lower than in the true Arctic. It is difficult to draw a hard and fast line between an outing in the northern woods and an Arctic survival experience. A summer day in Baffin Island is far less rigorous than a Christmas blizzard in South Dakota, but here the factor of isolation is paramount. Baffin Island settlements can be counted on your fingers. By comparison, South Dakota is a maze of heated restaurants.

A workable compromise between the Arctic, polar regions and cold weather areas is achieved if we consider, for the purposes of "arctic survival," all those northern localities likely to have one mean monthly temperature below 14° F. and less than one person per square mile.

A rough demarcation of the area so defined is latitude 60° North. This part of the world includes the Arctic Ocean which is ice-covered the year round. It includes the tundra, those level or slightly rolling treeless wastes which separate ranges of majestic mountains and occasional icecaps. It includes northern extensions of taiga, the forests of larch, spruce and birch which cover the areas intervening between the "high latitudes" and our homeland of familiar trees and fields. Physiographically, the diversified areas have one thing in common—a cool climate.

Cold is a miserable condition unless you are prepared to enjoy it. Very low winter temperatures occur when a locality is far from the equator, far from an ocean and in a lowland or valley bottom. The moderating influence of the Arctic Ocean, even through a film of ice, holds minimum temperatures at the North Pole to about −60° F. In contrast, inland areas of the sub-Arctic often are much colder. Verkhoyansk, near the Arctic Circle in eastern Siberia, has long been thought of as the Cold Pole, having been chilled to a record of −94° F. Recently, a temperature of −87° F. was recorded near the center of the Greenland Ice Cap.

To be hot in summer, again an Arctic locality must be far from the cooling effect of oceans. Temperatures rarely exceed 60° F. along Arctic coasts. Inland localities at similar latitudes occasionally warm to 100° F.

Cold, and here I mean an annual prevalence of freezing temperatures, causes a number of conditions in the physical environment which present problems to a survivor.

Plant Foods Covered

Ice and snow prevail from October to July. Plant foods are blanketed with snow. Many animals hibernate or migrate south. Fresh-water fish are shielded by the ice cover. Soft snow impedes movement, unless snowshoes or skis are at hand or improvised.

Frostbite is the freezing of any part of the body; this may be accelerated by wind-chill (Fig. 1). Frostburn results when flesh comes in contact with metal under freezing conditions. In spring and fall, the sun's rays are reflected from the snow surface and may cause snow-blindness or extreme sunburn.

On the credit side of the ledger, ice and snow provide potable water everywhere. Blocks of naturally compacted snow make an excellent shelter —the igloo of the Eskimo. Snug quarters may be excavated in a snowdrift.

Although the number of animals is limited, they are quite vulnerable. Land animals leave tracks and may be snared at burrows or trapped in runs. Several species of seal breathe through blow holes in the ice which are found under small domes of crusted snow. A short wait may be rewarded by hooking or harpooning a hundred pounds of nutritious meat.

Signal panels, dark smoke and the wrecked plane itself are plainly visible during daylight. Although accidents are commonplace, illnesses are rare. Germs do not thrive in cold.

The feeling of isolation is common to most Arctic localities away from the few established lines of communication. Chances of local help are extremely slim in Arctic regions. The solitary survivor or downed crew are all alone except for the possibility of radio contact with Air Rescue Service.

During the survival period, life is an interaction between fear and discomfort on one hand and self-assurance and capability on the other. Self-assurance is a matter of temperament, but it may be strengthened by experience and instruction. Capability results from intelligence, ingenuity, good training and common horse sense.

Isolation during the survival period may not be relished by Arctic survivors but it is an actuality that must be faced. Like a bald head or double dentures, not much can be done about it. Actually, you do something about it if you are isolated for an evening at home. Perhaps you read a book. As a survivor, you could do worse than read the survival manual and then find some of the animals and identify some of the edible plants described and illustrated.

Seasonal extremes of daylight and darkness result from the tilt of the earth's axis. Arctic nights are long, even continuous in winter; conversely, north of the Arctic Circle the sun is visible at midnight at least once a year.

Depressed Moods

Darkness presents a number of problems to the Arctic survivor. No heat is received directly from the sun in mid-winter, thus the cold reaches extremes. Outside activities are curtailed of necessity, although the light from the moon, stars and auroras, shining on a light ground surface, is of some help. Confinement to cramped quarters adds boredom to discomfort, and depression becomes the dominant mood as time drags on.

Without daylight, rescue by airplane is almost out of the question. A few moonlight landings have been made on frozen bays, and airdrops have been provided camps marked by flares or fires. Fortunately, the period of complete darkness does not last long.

Several other conditions, restricted to Arctic regions or of frequent occurrence there, have bearing on survival. A white-out may complicate a survival situation; more often it causes the accident which makes survival necessary. When the ground is snow-covered and the sky overcast, when light reflected by the snow has an intensity equivalent to that received from the sun, a white-out is the result. Everything seems hazy and looks milky. There is no horizon, no shadow, nothing to aid in judging distances. A man on the ground has to probe his way. Pilots have made unpremeditated landings on the Greenland Ice Cap.

Radio fade-outs in the Arctic are caused by solar explosions and sunspot periodicity. The accepted theory is that the sun emits electrified particles which produce heavy ionization on reaching the earth's atmosphere. This ionized blanket disrupts radio ceilings everywhere, but particularly in the polar regions. Long-term fadeouts may last for several weeks. As these are referable to sunspot activity, they may be forecast.

Short-term fade-outs, caused by solar explosions similar to the detonation of atom bombs, may occur in

Above is an SA-16 Rescue plane in a "white-out." At right a little shoveling and they survive in comfort. A good shelter is a basic survival requirement.

the Arctic both during daylight and darkness. The atmospheric disturbance is manifest about eight minutes after a solar explosion. The fade-out condition lasts from 15 minutes to several hours. It cannot be forecast. By blanketing radio reception, fadeouts are of obvious concern to survivors. Radios are unserviceable and communication leading to rescue may be delayed.

Magnetic variation is noticeable almost everywhere. A compass needle points to true north only from positions due south of the Magnetic Pole, or along the longitude on the far side of the North Pole from the Magnetic Pole. The peculiar condition in the Arctic is the enormous variation, up to 180° between the Magnetic and North Poles. A survivor who decides to travel between established points must know and allow for the local magnetic variation.

When the important environmental characteristics of the Arctic are recognized, the major conditions for survival become self-evident or can be surmised. For example, temperatures range from cool to frigid. An in-flight emergency may eject an airman from a warm plane into a barren waste of snow. To survive, he will need more than a T-shirt and tennis shoes. It is self-evident that warm clothing is essential to survival.

The same simple reasoning results in emphasizing the need for shelter. Figure One gives us this information: With a temperature of $-5°$ F., and a breeze of eight miles per hour, "travel and life in temporary shelter becomes disagreeable." Look what happens when it chills to $-30°$ F., and the wind speed doubles.

Fortunately, strong winds are rare in polar regions. The inland areas and the Arctic Ocean are among the most placid localities in the world. Sometimes strong winds sweep along the coasts and winds of gale velocities occur where a plateau descends abruptly to the ocean—as along the coasts of Greenland.

It can be surmised that food, lots of it, is essential for survival in the Arctic. The colder it is, the more rapidly heat is dissipated. The source of body heat is the food one eats. More food is needed to compensate for the accelerated heat loss in cold climates.

This method of studying cause and effect is one way to acquire knowledge for Arctic survival. Another method is to analyze the records of actual survival experiences. "Down in The North," a publication of the Arctic, Desert, Tropic Information Center, does just that in a review of what happened to the passengers and crews of some 268 planes, after they bailed out or crash-landed in the Arctic. Some interesting conclusions become apparent from the analysis.

It is far better to crash land than to bail out. The parachutist is alone for a worrisome period when physical injury is a possibility, and he may be unable to re-assemble with his fellow crewmembers. A jumper cannot carry much survival gear with him, and he is separated, permanently in most cases, from all the usable equipment in the plane, which may be lost or burned.

It is far better to stay put than to attempt to journey any distance in a rubber dinghy. Life rafts have and will continue to get men ashore from a ditching, but the record is zero for successful along-shore dinghy travel. Evidently the waves, or the wear and tear from ice or rock abrasion, soon make the rubber rafts unserviceable.

Driftwood may often be found strewn along most Arctic coasts. Below, right, polar bear meat can supplement survival rations.

Information Available

The very best method of appreciating the equipment and techniques essential to Arctic survival is on-the-job-training. Not all have had this privilege, but the information is available at second hand from evaluated experiences of the many men who have enjoyed living in the Arctic for months or years at a time.

Results from all of these methods are considered by the Air Force in establishing Arctic indoctrination courses and in preparing the authoritative manual 64-5 on "Survival" in all non-temperate environments.

The major conditions for Arctic survival are self-evident. But clothing, shelter and food cannot be dismissed with a paragraph each.

Clothing is confining. The more you put on, the more confining it becomes. Conceivably, when it is desperately cold, you could weight yourself down with scarves, sweaters, trousers, socks, and other insulating materials. This cumbersome assortment might keep you warm, though immobilized.

Specialists have combined our technical versatility with the tried and true styles of Eskimo skin garments (double parkas and double boots) to achieve a workable garb. Arctic clothing is scientifically designed and carefully fitted to provide insulation and ventilation while remaining reasonably lightweight.

The multiple layer principle of several layers of medium weight cloth in place of a single heavy garment allows for a windbreaker (to counter wind-chill), for the addition of more clothing to meet increasingly low temperatures and for easy replacement and quick drying of inner or outer layers as perspiration or precipitation lessens their efficiency.

Footgear is a subject in itself. Shoes or boots must be large enough to permit the wearer to put on several pairs of wool socks without pinching, yet small enough to prevent rubbing blisters, and they must be water-repellent. With an assortment of mukluks, shoepacs and other prescribed footwear available, an occasional character appears at an Arctic base in low-cut oxfords. Survival accounts contained gruesome details of what happened to lads who crash-landed in office shoes (these often snapped off in descents by parachute). Frostbites leading to amputations were commonplace. The miserable wretches spent their survival periods with their feet wrapped in cloth strips padded with moss.

Cold country landscapes look like this along the shores of icy Greenland. . . .

. . . and like this aerial view of a wooded section along the coasts of Labrador.

It is Air Force policy to keep the plane cool enough, when flying in the Arctic, to permit the wearing of suitable outdoor clothing. If an emergency arises, at least the men are properly clad.

Shelter permits needed rest. At a minimum it may be a parachute windbreak; by using ingenuity and effort, it can be a home away from home. A number of downed fliers evidently forgot, or never knew of, the insulating properties of snow. They chose the plane as the best available shelter and decided to wait it out in this windproof but cold-soaked compartment. Many of these individuals, when found by a rescue party, were frozen stiff.

A shelter by itself keeps out the cold but it does not guarantee a warm interior. Most Arctic survival kits contain burners for cooking and heating, and for melting snow and ice for water. All these burners use oxygen, so care must be taken to provide ventilation. Stove vents are needed to avoid carbon monoxide poisoning. A crack in the entrance and a small aperture in the shelter's roof provide enough circulation of air in the snuggest quarters.

You Need Calories

Food is a physiological necessity and its presence or absence can bolster or play havoc with morale. Our Army conducted exhaustive studies on ration issue. It was determined that 3,300 calories per day is the minimum number needed by soldiers who are working moderately hard in a hot climate. Expose the same soldier to a temperature of 14° F., and he needs 5,200 calories per day. If it gets colder, he needs still more food.

This increase in the number of calories normally means an increase in bulk. Much experimentation has been undertaken to meet the caloric requirement for the Arctic in highly nourishing, yet palatable small-sized rations.

Two years ago I was without rations for three weeks because my "rescue" from an isolated Arctic island was delayed. Two little plants named lousewort (the root is edible) and sorrel (the leaves are like water-cress) provided fresh greens; kelp furnished some bulk. The real staple was seal meat. Now seal is good. I still savor the thought of it. But the predominantly protein diet seemed to do little to ease hunger pangs. After just a few days, a daily intake of four to five pounds of seal in the form of steaks, roasts, stews and soups was needed to feel even moderately well-fed (this was embarrassing at a later date, until my stomach shrank to normal size). When rescue brought access to scales, I was 16 pounds over normal weight.

All this suggests that most men, and every survivor, can and should talk themselves into eating the food at hand when away from an a la carte menu. It is astonishing how thoughts dwell on good food when it isn't available. Thoughts are not bad, if they don't get the thinker down.

By now you either like the Arctic, or it leaves you cold. As a potential survivor you have a preliminary acquaintance with many of the conditions of the Arctic environment. Anticipating an inflight emergency, you plan to wear the most suitable clothing issued and to have at hand the most appropriate survival kit available, as well as some supplementary rations.

All of these may prove useful. Suddenly you are on the ground in the middle of nowhere, but you have been briefed on Arctic survival techniques and you are well equipped. The out-of-door life agrees with you. Still you don't plan to homestead the survival site. This introduces the allied subjects of communications and rescue.

There is a radio in the airplane and an emergency set in the survival gear. To insure speedy rescue, it is essential to communicate the best position or fix determinable, so the rescuers will know where to look.

Communication equipment, the instruction of personnel and Air Rescue proficiency have improved greatly in the past eight years. Nevertheless, the importance of a prompt and accurate radio report is self-evident.

Signal Techniques

If the radio is destroyed and the emergency set is left behind, things are bad but not hopeless. There are such things as signal panels, signal mirrors, flares and sea marker—the powder tints a snow surface beautifully. If there is wood available (driftwood is stranded on most Arctic coasts), fires and smoke can be made. The wrecked plane is a source of

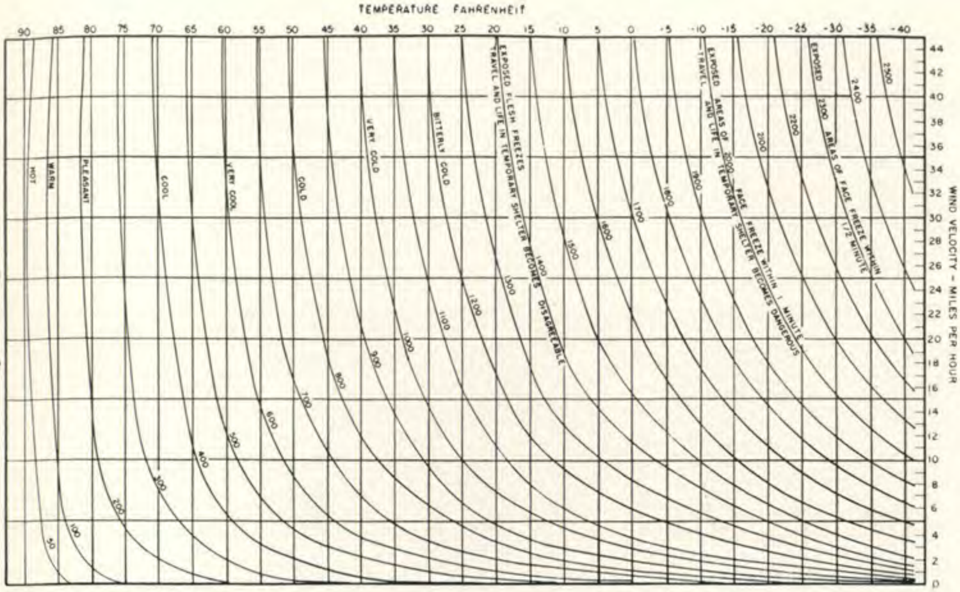


Figure 1. WINDCHILL NOMOGRAM

The "wind chill" factor is an index that indicates the rate at which the naked human body loses heat when exposed to various temperatures and wind velocities. This chart shows that high winds in areas of low temperature have a decided effect on the rate at which the human body cools. Note that with a wind velocity of 30 MPH, your face will freeze in one-half minute at 27 degrees Fahrenheit.

glinting surfaces and provides fuel for fires and smoke. Some survivors have signalled successfully by tramping out messages in the snow—even on the Greenland Ice Cap. The depressions show as shade in a sunlit surface.

Some individuals are just "natural born" survivors. They are stable, industrious, perceptive and self-sufficient. Others have trouble surviving in their home town. The Air Force is showing increasing concern in the screening of personnel for Arctic assignments. The Far North is no place for cripples, for sufferers from respiratory weaknesses, for men with poor circulation, for those allergic to wool or for the accident prone. The Arctic environment does not agree with neurotics, heavy drinkers, men with serious family troubles or maladjusted individuals. If these types are unsuited for assignment to Arctic installations, they most certainly are poor risks in survival emergencies.

Careful selection of personnel, thorough preliminary indoctrination and having and knowing how to use tested equipment, pays off in Arctic survival.

Nowadays most survival incidents are accounts of patience and planned activities to increase comfort, rather than of desperate makeshifts to keep alive. A World War II account of a C-47 down on the Greenland Ice Cap illustrates precisely how an inexperienced crew faced Arctic survival, and in contrast, what improvement the addition of two men trained in Arctic living made in the situation.

A C-47 crash-landed in mid-December. There were no injuries. The seven passengers and crewmembers succeeded in transmitting their approximate position. That was the substance of their constructive activity in the face of surface gusts up to an estimated 130 miles per hour and minimum temperatures somewhere around −50° F.

Airdrops of food and survival gear were made but the fearful seven recovered only a few of the packages. They simply huddled in their wrecked plane for four days and nights. The metal shelter could not be kept warm, even with two gasoline stoves and several layers of parachutes hung as an inner lining. They ate practically none of their rations.

On the fourth day a stripped-down B-17 attempting a landing, crashed near the wreck. This plane carried two crewmen trained in Arctic survival. These men knew immediately what to do. Their first action was the construction of a snow shelter. It was completed in three hours.

A plumber's furnace from one of the air-dropped packages provided a pleasant inside temperature of 60° F., in an additional half hour. Subsequent rescue attempts added the crews of two cracked-up gliders to the Ice Cap party. All were finally rescued with a ski-equipped C-47, fourteen days after the original crash.

By this time survival was being sweated out in comfortable hotel-like quarters. Two large sub-surface rooms had been excavated, stairway entrances constructed and parachute roofs secured in place. A tunnel connected each room to a subsurface, sheltered latrine. Another tunnel housed supplies, as airdrops provided more than was needed in food, clothing and sleeping bags.

Sleep in Comfort

Heaters were turned off at night but even then sleeping bags were comfortable only when stripped down to the summer liners. With heaters on in the day time, the men sat around in their shirt sleeves, usually in the room which was floored with a deflated life raft and lined with tarpaulins.

Gasoline was transferred to the stoves from the tanks of the C-47. The farsighted engineer of the B-17 had thought to bring a hand transfer pump with him. This able mechanic also thawed out and rigged the B-17's auxiliary power unit to supply electric light and radio reception to the hotel-bound survivors. An endurable Christmas was spent in warm comfort, listening to musical programs, gnawing on a pre-cooked turkey complete with trimming and in eating ice cream, provided on order by airdrop.

Primarily, survival in the North, as in other areas of the world, depends on two factors: in having the proper equipment with which to meet the survival problem and in knowing how to use it.

Preparedness, knowledge and courage in the face of an unfamiliar situation can bring you through the ordeal safely. ●

WHO GETS THE SNOW JOB?

THE pattern of "snowbank" accidents is almost standard. The great majority of these snowbank collisions are pilot error, pure and simple. They are caused by lack of judgment, lack of planning and poor pilot technique. There is also another important factor present, that of supervision. Granted that the pilot must keep his eyeballs uncaged when landing at any airfield in winter, especially when there is snow cover; but planning of snow and ice removal from the facility itself is a definite responsibility of the commander and his operations officer.

If you expect two or more inches of snow at your base this winter, by now you should have set up your snow removal plan, as required by AFR 90-6, and as augmented by T.O. 00-105B-1.

The snow removal plan encompasses a great deal more than the actual clearance of snow from your taxiways, ramps and parking areas. Your plan must be carefully thought out, and coordinated with Operations and Installations. Contingent upon the removal of the snow itself are factors such as runway marking, protection of lighting fixtures, ramp and taxiway clearances, approach and clear-zone clearances and most important of all, a firm policy on flight operations. This last item should take into consideration the importance of your mission and whether or not flying should be shut down during periods of extremely heavy snowfall and attendant weather conditions such as sleet, ice, slush and ice fog.

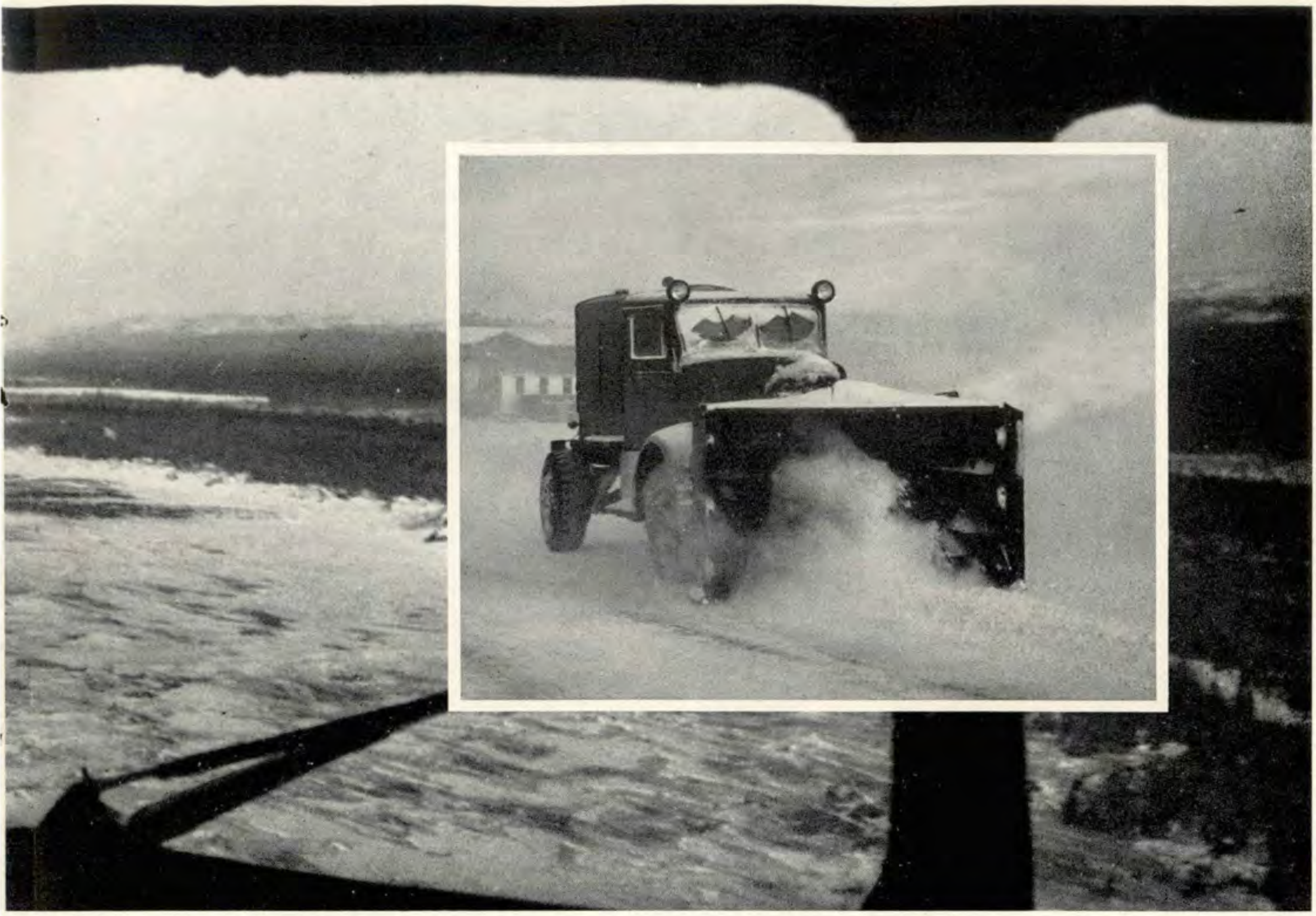
There are times when snow removal crews, with all the equipment they can muster, cannot keep up with heavy snowfall. Ice or slush on runways, taxiways and ramps, heavy enough to preclude all braking action, presents an accident potential with an extremely narrow safety margin.

Once you have your snow removal plan and its basic policies set in your mind, outline the plan in detail and coordinate it with Operations, Installations and Weather. Although snow removal is primarily the responsibility of Installations, Operations should have overall control wherever flight or ground movement of aircraft is a factor.

Your plan should include a map of the airfield, actual areas to be cleared, and routes for snow removal equipment. The plan should also include an equipment list, showing the vehicles on hand, types of vehicles and capacities. Besure you not only have all the necessary equipment, plus spares, but that it is in serviceable condition.

In addition, have an emergency set-up on equipment so if you run into trouble you can borrow needed equipment from nearby municipal agencies. Remember, construction men are used to helping each other out of tight spots and you will find them more than willing to pitch in and help out when needed. Another important part of your plan should detail the number of civilian and military personnel assigned to snow removal, plus stand-by crews to help out in an emergency.

Tied in closely with your snow removal operations should be the Weather Officer. When snow is im-



pending, Operations and Installations should be notified automatically.

The Operations Officer should be the project officer, responsible for monitoring the snow removal and area marking program. Installations should furnish the "pick and shovel" work, but the overall problem should be closely controlled by Operations. At one Air Force base in the "deep snow" country, the snow removal crew works under the direct supervision of a snow removal foreman, who in turn works under the Operations Officer. The Operations Officer notifies Installations when he wants the snow removal crew to start, which is usually when the snowfall reaches a depth of two inches. The snow removal crew foreman operates from a radio-equipped jeep which is in constant touch with the control tower.

Have snow removal crews work together at all times in a manner similar to the aircrew system. Assign the same men the same equipment and keep the crew in a unit.

An important item in safe operation under winter conditions is a foolproof system of incident and near-accident reports, which requires all pilots taking off or landing at your base to report surface conditions of ramps, runways and taxiways. A pilot cannot always depend on weather reports or NOTAMS being absolutely up to the minute in stormy winter weather. Operations should keep a blackboard in the dispatch section, on which ground conditions are logged hourly, with the time of the last entry noted.

An important attendant factor to snow removal is the proper marking of runways, taxiways and ramp areas. At many bases in the North, these edges are marked with spruce boughs, erected at each runway light point and at other points spaced along edges of taxiways and ramps. They also give the landing pilot a reference point in "whiteout" conditions where perspective may be lost.

Another system in use employs sea-marker dye. The dye is mixed in the following solution: five parts water, five parts sea dye, one part alcohol. This solution is placed in a 55-gallon drum under pressure and sprayed on the snow. The edges of the runways are marked with a broad stripe, the thresholds of the runways are marked, and in certain instances a centerline is included. It is equally important that the edges of taxiways and ramps be marked.

Sand and ashes may be used instead of sea-marker dye, but the use of cinders should be carefully weighed when jet aircraft are involved, since clinkers conceivably can cause jet engine compressor damage. Sand in runup areas, especially where jets are concerned, is a must, providing it is evenly distributed, and compacted with a multi-wheel rubber-tire roller. As soon as the ice is under control, all excess sand must be removed with a power sweeper.

Remember that efficient snow control is a matter of teamwork and cooperation. Set up a workable snow removal plan and you'll find that your accidents, where snow on landing and parking areas is concerned, will show an appreciable decline! ●

ANOTHER FIRST TEAM!

Major Lawrence H. Johnson, Aircraft Commander.
Major Amon G. Bumgarner, Pilot (Center).
Captain Herbert H. Webb, Jr., Observer (Right).

CROSS FEED

LETTERS TO THE EDITOR

Amendment to 60-16

While studying the FLYING SAFETY Magazine for June, 1953, it was noticed that on page 13 there seemed to be an error. Paragraph four of AFR 60-16 quotes paragraph 11, AFR 60-16 dated 13 Feb. 53. We have an interim change to AFR 60-16 dated 12 May 53 which states we should fly to the right along low frequency airways and down the centerline of VOR Airways. The message we received is: Hq USAF Message Number AFOOP-OC-FL ALMAJCOM 491/53, DTG 12/2016Z, May 53.

We would appreciate a clarification and/or correction in your article.

Maj. Bernard W. Luster
Ops Officer, 1733d AT Sq
1706th ATGp, CNTLD MATS
Travis AFB, Calif.

FLYING SAFETY *Magazine went to press before the message referred to was received. Flying the right side of a low/medium frequency range is now directed by amendment 60-16A, dated 27 May 1953.*

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Where Is Your UHF Antenna?

Different types of aircraft have the UHF antenna installed in different locations, such as bottom or top of fuselage, wing tip, or vertical fin.

Since the UHF line of sight characteristics are straighter than those of VHF, it is likely that poor, or no communication will result if a large area of your aircraft is between your antenna and that of the other station. In trying to contact a control tower, for example, avoid shielding your own communication. Turn the aircraft if necessary so that there is direct line of sight between your antenna and the control tower antenna.

Col. Robert L. Schoenlein
Asst Chief, Mgt Insp Div, D/R&MI
10024 IG Group

Limitations of the Type B-2 Plotter

This Headquarters has been informed by WADC that the article in the Keep Current page of FLYING SAFETY, June 1953, entitled "B-2 Plotter Error Found," is correct.

The plotter should not be used to measure distance on a USAF LORAN Chart from 0° to 60° latitude, as the charts in this range are Mercator projections. The LORAN charts from 60° to 80° latitude are Lambert conformal projections for which the 1:3,000,000 scale on the B-2 is valid.

The LORAN Chart for the polar region, 80° to 90° latitude, is a stereographic projection which, for all practical purposes, presents a constant scale of 1:3,000,000 within the limit of the chart. The 1:3,000,000 scale on the B-2 plotter is therefore valid for use only with USAF LORAN Charts in the range of 60° to 90° latitude.

The Center has initiated the following action to correct the error:

- Requested the status of the Type B-2 Plotter be changed from "standard" to "limited standard."
- Requested the master drawing and Fig. 1 of Specification MIL-P-5127A be revised to identify the 1:3,000,000 scale as "N.M. on USAF L. R. Nav. Charts (60° to 90° Lat.)."
- Requested that the corrected plotter be assigned the name "Type B-2A."
- Requested that the Type B-2A be assigned the status of "standard."

Hq, Air Research and Development Command.

Maj. Gen. E. L. Eubank, Commander of Technical Training Air Force, presents Col. Stanton T. Smith, Lowry AFB, Colo., with Flying Safety plaque. The award covered the last six months of 1952 and represents more than 19,000 hours of safe flying time by Lowry personnel.

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Mid-Air Collisions

A few issues back, you discussed the hazards of mid-air collisions and pointed out that the greatest danger seems to be during VFR condition.

We have all experienced the momentary "thrill" of seeing the other airplane—just after it has passed a little too close—or have worried about the shadow of the airplane we can't seem to find. Around such busy places as Washington, New York, San Antonio, and Los Angeles, the problem will probably get worse before it gets better.

I have been kicking an idea around that may sound hairbrained but still may have possibilities. We never have any trouble seeing an airplane that is making a vapor trail.

Suppose we had a gadget a pilot could turn on in the control zone that would give off a pseudo vapor trail which would extend for about 100 feet behind the airplane and then vanish.

It seems to me this would increase the "see-ability" of aircraft by many percent and make VFR flying around busy airports indefinitely safer.

Major D. E. Ballard
Sheppard AFB, Texas

Keep Current

NEWS AND VIEWS

• **Aerial Tanker Tests** — USAF Air Research and Development Command has completed the first phase of tests designed to provide data upon which to base requirements for future high speed, high altitude aerial tankers and combat aircraft.

Two B-47 Stratojets were used in the tests. One, the "receiver" aircraft, was modified to mount a long, streamlined refueling probe jutting from its nose. The other, designated the K-47B, has an adaptation of the probe-and-drogue refueling system mounted in the bomb bay.

Modifications necessary to equip the B-47 as an experimental tanker include installation of the refueling equipment in the bomb bay, design and installation of the fuel tanks, pumps and lines and some additional cockpit instrumentation.

• **Cold Weather Demands Less RPM**—When taking off in cold temperatures, the pilot must control the RPM of the J-33 engine in order not to exceed its design limitations. At a given engine RPM the static thrust (designed for 4600 pounds) increases directly as the free air temperature decreases because the density of the air entering the compressor increases. In addition, fuel pressure increases under these conditions because more fuel is necessary to deliver the additional thrust.

Therefore, the pilot should adhere to the procedure of decreasing takeoff RPM as the free air temperature decreases. Of course, under emergency conditions, 100% RPM should be used.

The table below shows desired RPM for specific temperatures:

Fahrenheit Temperatures	Desired RPM
Plus 60	100
Plus 50	100
Plus 40	99
Plus 30	98
Plus 20	97
Plus 10	96
0	95
Minus 10	94
Minus 20	93
Minus 30	92
Minus 40	91
Minus 50	90

Gen. Nathan F. Twining, Chief of Staff of the Air Force, presents the 1952 Daedalian Trophy for flying safety to Gen. Curtis E. LeMay, Commander of Strategic Air Command. The trophy, awarded annually, is held by Col. C. J. Cochrane, Chief of the Flying Safety Division, Strategic Air Command.

• **Cold Storage** — Due to limited facilities, some air fields are forced to store aircraft outside during cold weather. Pilots flying these aircraft must remember two important points:

1. Any time there is moisture in the air at freezing temperatures, ice and frost accumulates on wing and tail surfaces, even if wing and tail covers are used. These surfaces must be cleared before takeoff.

2. Pilots should realize the possibility of windshield frosting or icing if a ground haze is present during takeoff. They then must be ready to go on instruments at any time during the takeoff run.

• **Where Did That Checkpoint Go?**—Traveling high and fast over snow-covered terrain in the Z. I. sometimes calls for astute jet pilotage techniques. When available, large check-points like mountain peaks in desolate areas are better to use. Of course, there are the usual "straight down" check-points such as towns, rivers, etc., when flying over populated areas.

Still, in winter many of these check-points have a way of camouflaging themselves and for the pilot tooling along in a jet there's no time to sit back and identify Punkinville village, which, according to the chart, should be just to the left of a river bend. Under these conditions one veteran jet pilot says: "Make a really careful check of radio equipment and of the radio facilities available along the first leg of your route, then rely on your radio and compass. Trust your instruments as you would in country where there are *no check-points*. It's only common sense not to take off under winter conditions without complete assurance that your radio equipment is O. K. for your flight."

FROM THE SOUTH SEAS TO THE ARCTIC!

WHEREVER you fly—North, South, East or West—be sure you're up to date on your emergency procedures and survival knowledge. Know your own limitations as well as those of your aircraft and equipment and you can play it cool in the tropics and warm in the Far North. Make it a point to *always* plan your flight with Flying Safety in mind.

Plan Ahead • Look Ahead • Keep Ahead

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