OCTOBER 1952

FLYING SAFETY

UNITED STATES AIR FORCE

IN THIS ISSUE: **SURVIVE IN THE ARCTIC • WATCH FOR ICE**

The Man Who Jumps for Your Life!

If you go down in the ice and snow country, or for that matter, in any wilderness, the pararescue member of the USAF team literally jumps into action for your survival. His prime mission is to get to you the fastest with the mostest equipment to help you survive until rescued. Do your part for the team by knowing how to take care of yourself while waiting for help. Know all you can about survival until your team reaches the scene . . . it may be a long journey home.

pararescue leads the survival team

Winter Section . . .

With winter rapidly approaching, the time has come for all good pilots to start reviewing the procedures which experience has shown will help them to avoid becoming victims of winter flying hazards. The fact that

flying in winter is more hazardous than in any other season of the year is very apparent when it is considered that all the usual pitfalls are still around — plus those of snow, ice, sleet and just plain cold weather. It cannot be denied that special techniques are necessary, that flight planning must be more thorough and that each pilot must exercise even greater caution and alertness during this season. To help you prepare for winter operations, the first half of this issue of FLYING SAFETY is devoted entirely to winter subjects.

ADIZ Procedures . . .

On page 16, you will find a short article which is mainly made up of examples from the files of the 4704th Defense Wing at McChord AFB. These examples illustrate the fact that when pilots fly through ADIZ's without using proper reporting procedures, they may well be jeopardizing the safety of their fellows who are assigned the job of defending these vital zones against possible attack. Although we have not investigated the problem in other areas of the country, we have a hunch that similar examples clutter the files of all other Interceptor units.

The Cover . . .

T/Sgt Steve Hotch stopped working on "Rex Riley" long enough to turn out a fine survival illustration. The moral of the cover is, of course, to stay near the plane if you're forced down in a wilderness.

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FLYING SAFETY

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In the far north the natives' abilities often pull the white men through the tight spots. If you follow the Eskimo's lead, you'll . . .

SURVIVE IN THE ARCTIC!

By Major Harold L. Strong, Medical Safety Division
Directorate Flight Safety Research

MAY IT NEVER happen to you! But if it does—your hide will be a lot better off if you digest these few hard facts and suggestions about your Arctic Survival.

Omitting the human factor, actual survival has followed the same basic pattern all over the entire world.

The primary requisite for survival is *preparation*. The active requisite is *precaution*.

These two phases of survival are inseparable. In polar survival they are an absolute necessity. Possession of the proper equipment; the knowledge of how to use it where and when required and the will to live—these are the bedrock "musts."

In the Arctic, the primitive living ways of the Eskimo and Indians provide the key for land, sea and sea ice survival. Their fire building and fat burning techniques; sod and snow shelters; use of furs and grasses for body warmth, their hunting and fishing methods, especially in winter, and their sea ice living and travel—these are the big payoff bonuses for those who value their continued existence. One man who possesses this knowledge can save the entire crew. The saga of early Arctic exploration is filled with acknowledgments of the northern native's abilities to pull the white men through the tight spots.

Beginning at the beginning, survival training should be accomplished by air crews as units—complete flight units of officers and airmen. The reason for this is plain. In an emergency, orderly procedure is vital. The value of teamwork cannot be over-estimated. Again, let us stress the fact that subconscious compliance with orderly emergency procedure is vital to survival especially in the initial phases of bailout, landing and the first steps to securing one's self.

Review a Crash

As an example, let us review the crash of a B-29 on takeoff at Ladd Field, Alaska. Luckily, it was a takeoff crash at the edge of the field. No one was badly hurt — but when the plane came to rest — out went the crew—with not one shred of survival equipment or proper clothing. The ambient temperature was $-54°$ F. Had they cracked up 10 miles from the field, it is very doubtful that help would have reached them in time. It is certain that cases of third degree frostbite would have been numerous, to say the very least. It is true that one engine was on fire when the plane crashed, but the point is that the subconscious survival procedure included only immediate bodily survival with no regard for even the next five minutes of existence as individuals or as a group.

To forestall such action, it should be apparent that crash-landing, water-ditching, and bailout procedures must be continually reviewed and practiced.

Once down, the length of your existence as survivors is directly dependent upon the speed with which search planes find you.

In the Arctic winter, snow writing is a most effective means of signalling. There is a qualification here, however. The writing, to be visible and legible from the air, must possess color contrast. On snow the contrast can be made by removing shallow snow from the ground or by digging deep trenches in deep snow to create shadows. When the light is faint, as is the case in the depth of winter, the trench must be filled with

About the Author . . .

Major Harold Strong knows whereof he speaks. Since 1927, he has lived and worked and served in the far reaches of the Arctic Circle.

By utilizing Eskimo methods, he was able to develop an Arctic survival technique, which has been adopted by the Air Force. From 1942 to 1945, he was Base Rescue Officer for the Greenland Base Command, working in close cooperation with Col. Bernt Balchen, one of the Air Force's top Arctic specialists.

After the war, he founded and conducted the Arctic Indoctrination School at Marks AFB, Nome, Alaska.

some dark liner. Besides aircraft parts, spruce branches, drift logs, brush and tundra moss can be used on land. Rags, insulation of the plane, etc., can be used on sea ice.

Sea marker from your life raft or vest can be used as a signal on snow or on open water leads or cracks within the sea ice. Check to make sure your life raft contains the dry marker. For use on snow, dilute the powder in water if available. It will cover a much greater area when sprinkled.

In timber country, both winter and summer, every green spruce tree of good height is a potential day-smoke or night-flare-signal of excellent visibility. Select a tree that is heavily branched—and in winter one that is not over 10 or 15 feet high. Big trees are too hard to keep free of snow.

Gather the dry dead twigs from other trees. Beat them free from frost and snow. They must be dry. Then build a big "bird's nest" of them in the lowest branches of the tree you have selected for the signal. Light the "bird's nest" and watch the tree go up like a Roman candle. You cannot make a better night or day signal. The smoke and flame are visible for miles. Don't confine yourselves to just one tree if you are lucky enough to land in timbered terrain — make plenty. Build them as high up as you can on ridges and hilltops. Gasoline thrown on the "bird's nest" really starts them off with a bang. Oil-soaked rags are good also for quick starting. Just be careful in summer that you don't light up more than you bargained for.

Your airplane is itself a good marker. Keep the parts you are not living in free from snow as long as you possibly can — especially the wings and the top half of the fuselage. The tail takes care of itself since it generally blows clear.

If your fuselage is livable, screen off just enough room to live in, using parachutes or snow blocks. Be sure to cover the entire outside of your living space at least one foot thick with snow. Keep it covered to prevent heat loss. Any place is warmer than a bare fuselage exposed to the cold and wind. The bare metal is a conductive super thief of your precious heat.

Use the Plane

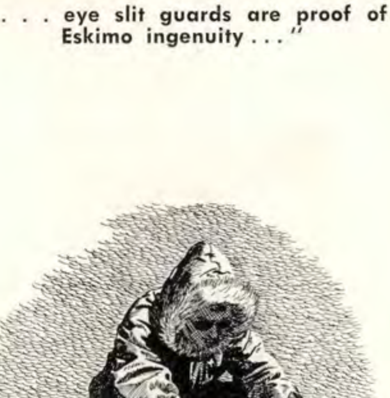
In the dead of winter, if you build snow walls under a wing, bank the whole shelter, including the wing so that a dome effect is formed. If this banking is not well done, the wing will vibrate in high wind, squashing the top blocks and letting in the driving snow. The constant vibration of the wing makes repair impossible until the wind has ceased.

The weight of the banked snow on top of the wing will reduce vibration and provide insulation. However,

At left is one good type of Arctic tent being constructed with snowshoes. Tarpaulins or parachutes are thrown and tied over the improvised ridgepoles to serve as a windbreak. The airplane fuselage can also serve as a good shelter if properly banked with snow. The snow will serve as insulation.

" . . . snow writing is a most effective means of signalling."

" . . . eye slit guards are proof of Eskimo ingenuity . . . "



"The best blubber stove is made from a coffee can."

" . . . you can break in on the eating cycle."

Don't attempt the superman method of igloo building.

Snow shoes make travel much easier in the Arctic.

just to forewarn you, the under side of the wing will condensate, even from your body heat and breath. So each time you build a fire, it will drip. Brushing off the accumulated frost prior to lighting your fire will reduce the drip. The solution is to evacuate and build a snow cave.

Waking up with two feet of swirling snow over you and stumbling around in the dark trying to find your precious gear and light to block up again in a vortex of flying snow is strictly for penguins.

If you happen to be in the vicinity of a long deep snowdrift extending from a pressure ridge on sea ice, a high bank on the coast, a deep gulley filled with snow, or an ice cap, then by all means dig a snow cave. The snow cave is the easiest to construct, most secure, and warmest of any type of snow shelter.

Know First Aid

First Aid procedure, with special reference to the prevention and treatment of frostbite and snow blindness, is of major importance.

It is a good plan to see that one man forward and one man aft in multi-engine aircraft take advanced courses in the administration of blood plasma, drugs, surgical sewing and emergency amputations. This suggestion is of particular importance especially as regards polar emergencies. Long range flights over great uninhabited areas indicate what otherwise may well be fatal delay in the arrival of outside medical help.

Frostbite is an old acquaintance of all you who have flown high altitude missions. Those who live in the Arctic know that to get frostbitten is solely due to bad planning or just plain carelessness. They go on the basis that if you are properly fixed, then the fixes you get into can't fix you.

This same code of advance prevention applies to snow blindness. This affliction is as crippling as two broken legs and two broken arms. The terrific number of pure and refracted solar rays literally burn your eyes. You will lie in excruciating pain for from three to six days in one of the prettiest flaming holocausts you could ever hope to see. You can go snow blind on foggy misty days as well as in bright sunlight when the sun is high.

Luckily, the snow blindness season only lasts on the low lands from about the 15th of March until the snow melts in late June. On the sea ice, it is waiting for you from about the first of April right straight through the summer and well into October. At high altitudes on permanent snow cover danger exists at all times.

To avoid snow blindness, never be without your sun glasses. Carry an extra pair. Daub your cheek bones and the areas over and under your eyes with burnt wood or soot from a stove or oil fire. These "blackeyes" will cut down refraction from those surfaces.

If you have the hard luck to lose all your glasses, let us hope you have some wood, bone, or plastic out of which you can fashion two "lenses," having a small slit not over 1/16 of an inch wide and about one inch long. These slits should be located so that the center of the slit will center on your pupil when the lens is

How to Live Longer

Your parachute can be a life saver when you're down in ice and snow country. It can be used in many ways. Here are some of those ways:

- Clothing; mukluk boots, puttees, neck and face cloths, eye shields, hats, handkerchiefs, scarfs.
- Shelter; blankets, bed-rolls, tents, lean-tos.
- Hunting and fishing equipment; slingshots, snares, fish-hooks and lines, seines and nets.
- First aid; litters, splints, bandages, dressings and slings.
- Miscellaneous; travel pack, sails, awnings, snowshoes—you can even make a blackjack of your parachute.

An ice saw is a valuable tool in the Arctic. These men, who are going through training at a survival school, are using saws to cut snow blocks for an igloo shelter against the cold.

Here, the snow blocks are going together—notice the technique toward dome type construction for strength and which also minimizes the water drip from melting snow.

held to it. The slit can be easily made by making up or splitting each lens in two pieces and tying them together after cutting the slit. The material should be about 1/4 inch thick where the slit is cut. Blackening the top and bottom of the slit is of great help. Even a strip of cloth—the darker and heavier the better—is a help. Simply cut slits and ravel the edges a bit.

The eye slit guards are one proof of Eskimo ingenuity. By blocking off better than 60 per cent of the refracted rays, slit guards of any type will serve in an emergency. They should, however, not be used over long continuous periods of time.

Your eyes will tell you when to head in for a shaded or dark place. You will first start blinking, as your eyes start to water. *Stop right there and duck for the dark if you possibly can.*

If you don't, you will find that your vision will take on a pinkish haze that will deepen in color as you blink harder and the tears run faster. Soon all you will see is a flaming, whirling vortex. That is all you will see because you can no longer hold your eyes open.

Snow blindness, like frostbite, can be prevented in all but the most exceptional cases. Believe us, the pains taken to assure prevention are worth your most earnest effort.

Your Survival Kit

In the Arctic, just as anywhere else, it is the things you haven't done and the things you don't have that make you lose out. There is no phone or store once you are down in the north country! It's strictly what you have with you when you crash land or bail out, at least until you are found.

Those who have their airplanes with them are lucky indeed. As you know, a wealth of material is in a plane—even though it may be pretty well bent or burnt. Don't throw away anything. Keep everything—even the bones of a seal are needles, spears, parts of a stove. You never can tell just what you may need. The stuff first considered useless may be just what you need, those seal bones, for instance. The seal's blubber won't burn without a wick. They are the wick. Make a little pyramidal pile of its bones on a stone or metal sheet. Use the shoulder blade as a shelf for the blubber. Saturate a small rag with oil from the blubber, light it, place it inside the bone pile and lay the blubber carefully on the shoulder blade on top of the pile. The heat will render the oil from the piece of blubber. The oil will drip on the heated bones and ignite.

The best blubber stove is made from a standard one-pound coffee can with the cover removed. Punch it full of holes — small holes not over a quarter of an inch in diameter are best. Punch the sides and the bottom. Build a wick from a piece of canvas, dry tundra moss, or a piece of seal skin with the hair side up. Having impregnated the wick with oil, light it and place the perforated coffee can over the flame. Lay the blubber on top of the can. The oil, dripping from the blubber into the heated air inside the can, will burn far hotter than it does when the blubber is placed directly on the wick without the can.

The can is the white man's innovation, but the bone and blubber fire has served the Eskimos from time immemorial. The smell of burning blubber is somewhat akin to that which rises from the Chicago stockyards on a hot July day, but the cheery flame will certainly neutralize the odor.

You can construct a stove to burn the oil from your aircraft or the gasoline in the tanks. Just a word of warning about the oil in cold weather. Get it out of the aircraft as quickly as you can before it solidifies and is lost to you. Don't bother about a container if one is not handy—let it run into the snow. It will solidify there where it will be available when needed.

Snow is the greatest thief in the Arctic. Things dropped are covered and very hard to find. Things left out are often buried during a storm or blown away. Be ever so careful of what you have! Don't lay things down outside "just for a minute." The storm may be a long one. All caches outside your shelter should be marked by poles. They must be firmly planted so that the wind cannot flatten and bury them. If you have no poles, run a line from the cache to a stake at the entrance of your shelter. You can dig along the line to your cache.

We know three members of a rescue party who left their motor sled with most of their supplies not more than twelve feet from where they dug a shelter on the Greenland Ice Cap.

The storm lasted three days. They never found their sled. Digging living quarters for the crew one month later, the sled was found buried fourteen feet under the snow.

Use Snow Blocks

On the other hand, snow is the Arctic traveller's best friend. It supplies the only construction materials for shelter on the barren tundra and sea ice. Dug into, it is shelter. Cut in blocks, it is a house. Over it skiis and sleds slide. Without it, ground travel in the Arctic would be restricted to rivers and sea ice.

Contrary to general opinion, there is not a great deal of snow in the higher latitudes. What there is is blown into the form of drifts about ice hummocks and pressure ridges on the sea ice.

On the barren tundra, the tufts of last summer's grasses are always visible. The winds sweep all snow that is not held between the dark tufts on and on until it falls into a depression or over a high bank. If the winds did not clear these exposed areas there would be no musk ox or caribou in the Arctic.

It is one of the many paradoxes of the Arctic that drifts will soon form around a crashed plane on exposed barren tundra, thus presenting the survivors with snow blocks for shelter where before there was none. On the other hand, the very fact that the tundra blows so clear can prove a godsend to a winter wayfarer in hard times. Moss and twigs can be dug out for a fire. Last summer's blueberries can be found. Game is easier to see and trail.

The polar pack is not the dead white waste it appears to be. True, it is not a land of plenty, but polar bear kill seals. The foxes follow the bears to clean up the kill. The live seals eat Arctic cod. The cod eat plankton. Crabs eat what the bear and seal spill. Walrus eat clams they dig from the ocean's bottom. Birds swoop down on the remnants of anything. If you have luck and a little savvy you can break into this eating cycle and fare far from badly.

A shelter can be built out of ice blocks sawed from a newly frozen lead and frozen together. It is a cold shelter and it will drip but it is better than nothing if there's a storm. If you are lucky enough to have an architect in your bunch, you can really go to town. The ice slabs are right down the modernistic alley. A good heavy saw should be in every aircraft flying the polar areas—not a carpenter's saw—but piece of a crosscut saw about 18 inches long. It is fine for digging snow caves as well as cutting ice blocks, sawing driftwood or frozen timber.

The Will to Live

Not the least of your problems may be one which lies in your own mind. You have to fight against losing the will to live.

There have been cases of crews forced down in the Arctic and getting past all the initial hardships but gradually cracking up mentally as their hopes for rescue wane from day to day. Loneliness, a feeling of helplessness, boredom, worry and the inability to satisfy completely such physical needs as hunger and thirst are all unseen enemies which you must fight against. The weapons you have to use in this fight are activity, ingenuity, humor, a fighting spirit and faith. Probably the best of these weapons is well directed action because it not only aids in your mental fight, but also helps to improve your physical situation. After a few days of Arctic loneliness, success in snaring a rabbit, fixing up a more comfortable shelter, rigging up a signaling device — almost anything you accomplish will give a great mental lift. Set yourself small tasks which will keep you busy and help to pass the time until you are rescued.

Don't lose track of the days. Keep a record of time even if you have to do it by scratching on a small stick or by putting a pebble in a special pocket each day. It may not seem important now, but you can draw comfort just from knowing whether it is Monday, Friday or Sunday.

These are only a few of the high points of Arctic survival. We, who know the tundra and the polar ice, all realize one thing: we continue to learn something new every day. And the amusing fact is that so many of the little survival "tricks" we learn are very simple, like rubbing a wet, common match head in one's hair to dry it so it will strike. We saw an old Eskimo woman do it and it has worked for us on a couple of memorable occasions. Survival is an open book to those who value their skin enough to "read" it. ●

Rescuers inspect survival signs.

Your Fire and Shelter

ASIDE from its value from the standpoint of warmth, a big cheery fire can also be a great morale builder. But while building morale and dispensing warmth, it may at the same time be paving the way to disaster. A fire, no matter how big and bright, cannot take the place of shelter. The crew which neglects to provide itself with shelter, depending instead upon a fire, may find the going rough should the fire be scattered or put out by wind and snow.

WATCH FOR ICE!

Cold Weather flying is just around the corner and now is the time to bring yourself up to date on the icing problem

plan your flight to avoid icing areas —if that's impossible, know where to expect ice and what to do about it.

ICE IS nice to have around for various and sundry uses during both summer and winter. You might use it to freeze ice cream, or you might like to hear it tinkle in your tea.

How do you feel about ice when you see it piling up indiscriminately on your wings and props during flight? Do you feel a weird crawling sensation up and down your back, does your hair stand on end, do you feel like reaching for the panic button?

If you're smart, you don't have to suffer the above sensations—study up on ice, everything about it, read what your instrument manuals (AF 51-37, 51-38) have to say about it. Talk to your weather man about ice—plan your flights so that you can avoid icing areas, or, if you have to fly through ice, know where to expect it and know what to do when you reach it. You can blame your lack of confidence during icing conditions solely on yourself. Fear of ice during flight usually comes when you encounter ice unexpectedly. Even if you meet it unexpectedly, however, you will have nothing to fear if you know what to do.

If you're proficient in your aircraft, if you've studied icing factors and if you know the effect ice has upon the flying characteristics of the aircraft, then you'll fly with confidence.

The less experience a pilot has had with icing conditions and the less he knows about ice accretion, the more likely he is to find ice a hazard. Flight can be accomplished during icing conditions if the pilot determines the best flight altitude, understands his de-icing equipment and is familiar with the aircraft's limitations under icing conditions.

Except in the form of frost, ice accretion occurs only in rain or in clouds where there are water droplets at a temperature below freezing. A pilot need seldom encounter icing conditions unexpectedly. Prior to his flight he should consult the forecaster and study the upper air and adiabatic charts in order to plan his route of flight. Regions of probable icing are forecast with ease. During the flight, icing conditions may be anticipated by observing the trend of the free-air temperature and the presence of visible moisture in clouds or rain. Icing may be expected where there is visible moisture in the air and the temperature is at or below the freezing level. The severest icing is encountered in clouds which contain large amounts of liquid water; ice accumulates in proportion to the rate at which liquid water is deposited on the aircraft.

The three basic types of ice are clear ice, rime ice and frost.

Clear Ice

Clear ice forms on aircraft when supercooled raindrops or cloud droplets strike faster than they freeze. Thus the outer surface is always wet with an excess of free water. The ice forms from the aircraft surface out. It generally conforms to the shape of the structure to which it freezes and is slow to distort the form of a leading edge of a wing. The excess of free water, however, will flow back over the top or bottom of the wing and part of it will freeze there, roughening the wing surface. This roughening greatly increases drag and also increases the stalling speed.

Centrifugal force ordinarily keeps the propeller blades free of clear

Rime ice will cut down on prop efficiency

This B-29 nose shows ice picked up in flight

Ice down south—these T-6s were on a field in Texas

ice. Near the hub, however, an accumulation of ice may develop, causing vibration. The severity of the vibration will be determined by the amount of ice collected on the blades. Serious power loss is seldom experienced; however, if the vibration becomes too severe, it may be necessary to reduce power to avoid structural damage to the aircraft.

Rime Ice

Rime ice is easily recognized as a porous, white ice that is usually granular or feathery in appearance. It is not so dense as clear ice. It forms when water droplets freeze as soon as they strike the aircraft. Since this freezing is almost instantaneous, there is no excess of liquid water and the rime ice forms only where the droplets hit. This is principally on leading edges, but rivet heads and minor protuberances may also accumulate rime. Rime ice is more easily removed than clear ice. Although it freezes rapidly and may form on the propeller blades, centrifugal force plus de-icing fluid will usually dislodge the ice, restoring propeller efficiency.

A very light accumulation of rime may form a narrow sharp-edged bead of ice along the leading edge of the wing. This light accumulation may appear inconsequential but if the airspeed is reduced, as for example in a landing approach, the change in angle of attack and the small bead of rime may then have a dangerous effect upon the stalling speed. The only safe rule is to maintain an excess of airspeed above normal stall speed when there is ice upon the wings.

Frost

Frost is made up of individual crystals of ice which adhere readily to the skin of the aircraft. It forms when the air next to the surfaces of the aircraft becomes supersaturated with water vapor at or below freezing. The vapor then turns to ice without passing through the liquid state. Frost usually forms in clear air, and cannot always be foreseen.

A heavy accumulation of frost may gather on the wings of an aircraft parked overnight in the open. When this happens, don't try a takeoff until all frost is removed—you may not get off the ground.

Frost may form on an aircraft in flight if it enters an area of moist air after flying through a cold air mass. This could occur when flying through a front from the cold-air side. The only real hazard to flight is the restriction of visibility when it covers the windshield. If it persists on the wings and control surfaces until a landing is attempted, keep the airspeed higher than normal throughout the pattern and final approach. This will help correct for a probable increased stalling speed.

Do not attempt to fly through any known icing condition unless the type of mission demands it. Even with full de-icing equipment, flight through icing regions should be un-

Propeller tip shows ice buildup on leading edge

C-54 with "plumbing" flew for ice research

Taxiing the ski-equipped plane on ice or snow calls for more skill and technique.

dertaken only for the purpose of reaching a safer flying level.

De-icers were developed as a safety device in case of trouble. If an extended flight through an icing condition is necessary, the pilot must be fully acquainted with the effect of de-icers on the control characteristics of his airplane during level flight, maneuvers and landing. He must know to what extent the stalling speed or other flight characteristics are altered by inflation and deflation of the de-icer boots. Inflation of the boots may cause stalling at speeds the pilot is accustomed to consider safe. *Therefore, de-icers must never be left operating during landing or takeoff.*

When to Use De-icers

Whenever possible, the propeller, windshield and pitot head de-icers should be placed in operation before the icing region is entered. A good practice is to permit the deposit of about one-quarter inch of ice on the wing boot before inflation is started. Break the deposit clear, then operate the de-icers intermittently as new deposits form. This will work all right if rime ice is encountered. If it's clear ice which forms behind the boots and which can't be removed, discontinue use of the boots. If the boots are operated continuously, a new sheet of ice may form over the cracked ice on the boots, and the tubes will pulsate ineffectively beneath a flexible sheath of ice. Under some conditions ice formation is extremely rapid, and continuous operation of the boots may be necessary.

Ice may sometimes be removed from propeller blades by rapid increase and decrease of engine RPM. This method, however, is not advisable unless all other efforts have failed. There have been a few instances where crew-members in the cockpit were injured by pieces of ice which were flung through the side windows. Before increasing the RPM, make certain that all crewmembers are clear of the prop areas on both sides of the cockpit. Besides this hazard to personnel, there is something else to consider: Ice on the blades may cause the propeller to stall because of increased loading when emergency power is used.

One of the best ways to prevent the props from icing up is to use the prop de-icers as anti-icers. When you definitely anticipate icing, turn the prop de-icer on, allowing the blades to be covered with de-icing fluid just prior to entering the icing region; the ice will not have a tendency to adhere to the blades if they have been generously "anti-iced." Avoid any prolonged flight in the icing area. The amount of de-icing fluid carried aboard the aircraft will usually only last for about two hours with normal use. While we're on this subject, don't forget to check the level of your prop de-icer fluid prior to takeoff when you anticipate icing conditions along the route. Use the de-icing fluid to climb out of the area or long enough to make that 180°.

Remember:

- Avoid ice.
- If icing regions cannot be avoided, flight through them should be as short as possible and should never be attempted unless effective de-icing equipment is available.

Carburetor Ice

Carburetor ice is due to the refrigeration occurring in the induction system of the engine. Ice usually forms in the supercharger adapter or on the butterfly-type of throttle valve and will eventually close off the air passage. Since the fuel flow is not interrupted, the formation of ice in the carburetor venturi will be indicated by a rapid increase in the fuel-air ratio, resulting in power loss and eventual stoppage of the engine. The most positive indication of carburetor ice will be a drop in the manifold pressure. By keeping close watch on the manifold pressure gage, carburetor ice may be eliminated before it becomes too serious. Application of carburetor heat at intervals will usually be sufficient, allowing the engine to develop its full power between applications.

Cooling of the air in the engine induction system amounts to 10° or 15° C, in the average aircraft engine. It is possible to have ice form in the adapter when the outside air temperature is as high as 15° C. The refrigeration is the result of the evaporation of gasoline and the expansion of air through the venturi and behind the throttle. If the cooling is sufficient to produce condensation of water from the inducted air, carburetor ice may form when the plane is flying through clear air.

Judgment must be used in watching the manifold pressure and in applying carburetor heat as soon as a drop in manifold pressure is noted, in preference to running the engine with carburetor heat on at all times. However, if serious carburetor icing is expected in clouds or precipitation, do not hesitate to use carburetor heat as a preventive.

Climb From Ice!

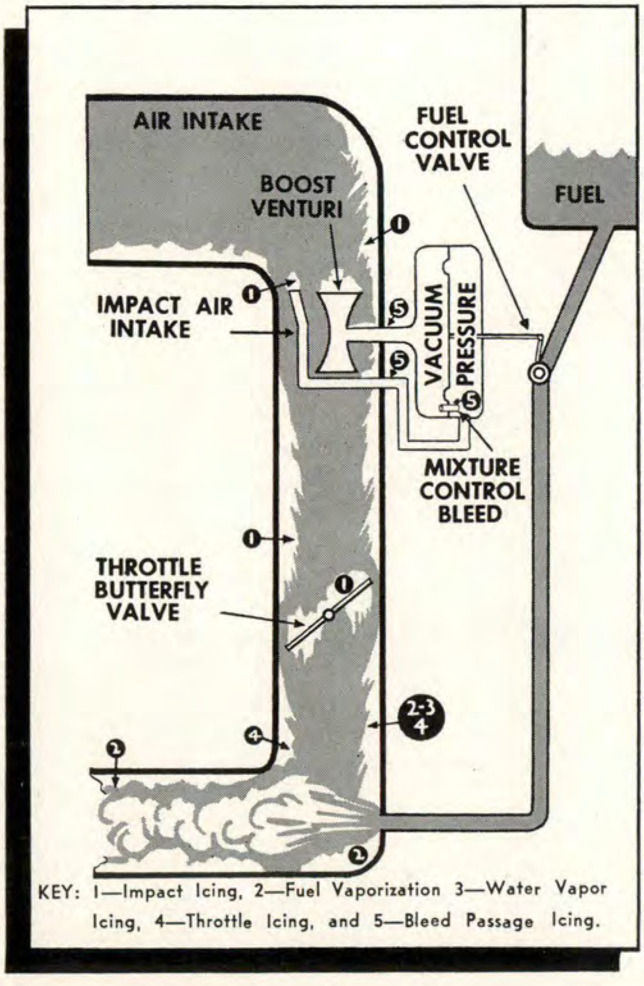
Icing is likely to occur below temperature inversions, along fronts, and over mountains. Temperature inversions, typical along a polar front, are caused by a relatively warm air mass rising above sub-freezing polar air. Moisture falling from the upper warm air through the lower cold air cools to sleet, freezing rain, or snow, and usually forms clear ice.

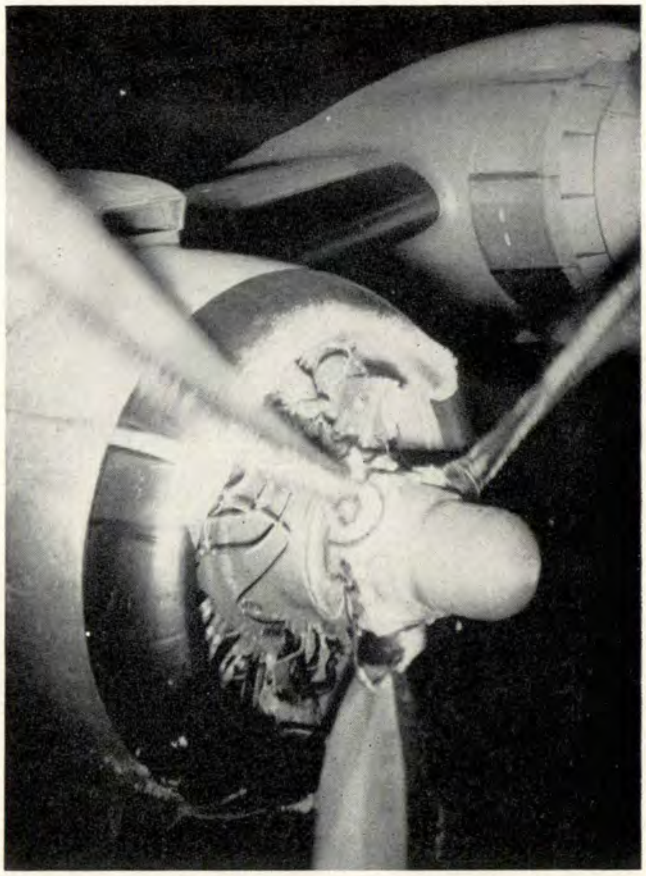
• Climb in all types of icing except sleet. The climb will be either to colder air where the rate of ice accretion will be slower, or, in the case of freezing rain, it will be a climb to warmer air above. Continue the climb as long as the temperature continues to rise.

• When sleet is encountered, hold altitude or descend. A descent should never be made unless warmer temperatures are known to exist below and ceiling and terrain are such that the descent may be made safely. All changes of altitude must be cleared by ATC and Flight Service should be notified.

• Airspeed should be lowered during flight in icing conditions. Do not fly at speeds lower than normal traffic pattern airspeed, however, as this may cause ice on the lower side of the wings where de-icer boots and thermal anti-icers have no effect.

• When climbing or descending through icing conditions, use normal airspeeds with the highest rates of climb or descent practicable.





This photo shows ice forming on a propeller and engine of a C-54 which was used to fly missions in the USAF's research program on icing. Jet engines pose new research problems.

Jets flying in the colder Arctic regions are not faced with as many icing troubles as one would suppose. Although extremely low temperatures are encountered, lack of moisture in the air lessens ice formation.

Jet Engine Icing

The largest icing problem confronting the jet pilot is induction icing. If he knows when to expect it, what to expect, and what to do about it then there's no real problem—for *knowledge is the way to confidence.*

The problem of air inlet icing in turbo jet engines was recognized by both the Military services and the aircraft engine industry in the early stages of the jet engine development program. A considerable amount of laboratory testing had been accomplished as early as 1944, and icing flight tests were begun on a J-31 (I-16) centrifugal compressor type engine mounted in the bomb bay of a B-24 airplane. These tests were followed by icing investigations conducted on the Juno 003 axial flow engine which was captured from the Germans.

Early in 1947, the NACA Lewis Flight Propulsion Laboratory at Cleveland, Ohio, installed a water spray system ahead of a J-34 axial flow engine while evaluating its performance in the altitude wind tunnel, and subjected it to simulated heavy flight icing conditions. In a matter of minutes engine had to be shut down because of excessive tail pipe temperatures caused by the throttling effect of the ice accumulations in the air inlet system. As a result of this demonstration, a decision was made to conduct further tests on a jet aircraft under actual icing conditions in an attempt to evaluate the relative ability of the engine and airplane to withstand icing.

After a study of various possible methods and locations for conducting the test program, Mount Washington, New Hampshire, was selected as the most logical test site. The Air Materiel Command was then operating an icing research facility at Mount Washington. During the winter season icing conditions prevail approximately 25% of the time. The abundance of such natural icing conditions may be attributed to the geographical location, in the northeast storm track. Most of the "weather" which is born over the Great Lakes Area passes through Northern New England. As an additional factor, the western approach to the mountain provides a gradual and somewhat even lifting process of the approaching air masses. The rapid lifting of the air by a vertical distance of almost a mile, over an approach run of several miles, creates the condensation and cooling of the moisture necessary for icing conditions. The lifting process also creates the supervelocities over the summit and the characteristic high winds for which the mountain is famous.

Test Program

An extensive test program for the J-47 engine was established at Mount Washington in 1948. Various designs of anti-icing systems were tested in a full scale J-47 engine.

After two winter seasons of testing at Mount Washington, a J-47 engine equipped with the most promising type of anti-icing system was installed in a B-29 flying test bed. Many flights were made under actual icing conditions and a considerable amount of valuable jet engine anti-icing data was obtained. The jet engine anti-icing program was beginning to move forward, and plans were started for the introduction of jet engine anti-icing provisions in future production aircraft.

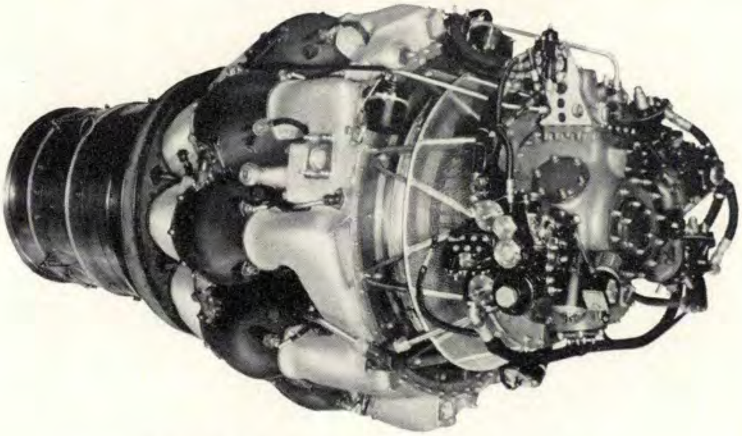
In 1951 the importance of jet engine anti-icing was brought to the front with a terrific impact when several jet fighters crashed simultaneously because of air inlet icing. It was then decided to move into the jet engine anti-icing program with an all-out effort.

From the tests conducted at Mount Washington and other experiments, and from the knowledge which has been gained in recent years through operational experience, there is a wealth of information on jet engine icing available to jet aircraft operators, both pilots and ground crew personnel.

As in all problems regarding ice on aircraft, i.e., ice on the wings, etc., certain atmospheric conditions must prevail at the time. The principal meteorological factors that contribute to jet engine icing are liquid-water content, air temperature, and droplet size. A definite amount of moisture content must be present in the air, and the air temperature must be within a given temperature range. Icing conditions are most prevalent when the outside air temperature is between a plus 5 degrees F and a plus 32 degrees F, and the liquid water content ranges between 0.1 and 1.0 grams per cubic meter. Under these temperature conditions, all ice-producing moisture conditions are not discernable to the pilot or crew member.

When the air is not saturated and clouds, fog, frost or light mist is not visible, ice formation can only be discerned on some external part of the aircraft. Generally, when the moisture content in the air is relatively high, and the temperature is within the described limits, ice is deposited in appreciable quantity on any object passing through it. A high moisture content is required to deposit ice on the wings which will be visible to the pilot.

A moisture content too low for wing ice formation may still cause ice to form in the jet engine air inlet system, however. Atmospheric pres-



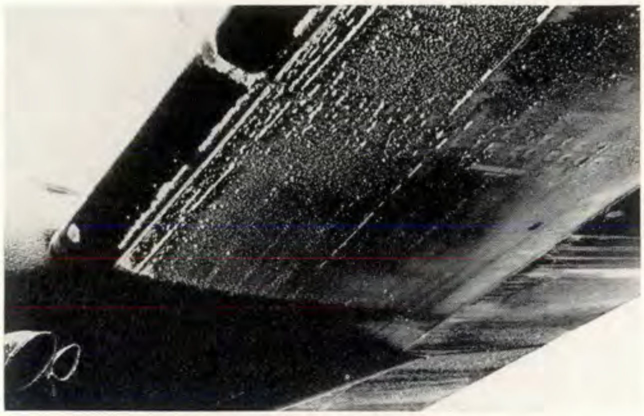
Anti-icing for Jet Engines

The following table indicates engines that have anti-icing systems installed and engines that do not, together with their associated aircraft. No anti-icing provisions:

J-47-C-7	F-86A,E; B-45 all models
J-47-C-13	F-86A,E; B-45 all models
J-47-C-9	B-45, all models
J-47-C-15	B-45, all models
J-47-C-11	B-36D; B-47A
J-47-C-19	B-36E, D, (plans to anti-ice by retrofit)
J-35-3 through J-33	B-45A; F-84A, B, C, D, E, G; F-89A, B, some C.

With anti-icing and retractable screens (automatic on inlet guide vanes by continuous application of the bleed air. Accessory section cover and island fairings are heated by separate system actuated by the pilot): J-47-E-23, B-47; J-47-E-25, B-47; J-47-E-27, F-86F; J-47-D-17, F-86D; J-73-3, F-86H. With anti-icing and no retractable screens: J-35-33A, F-89C, D. Complete anti-icing system, retractable screens, fully automatic: J-35-35, F-89F.

All General Electric engines whose design is more recent than that of the J-47C model (-7, -9, -11, -13, -15, -19) are completely anti-iced. That means the J-47D model (-17) in F-86D, the J-47E models (-23, -25, -27), and all J-73 models will have anti-icing protection when first delivered to the USAF.



Rough rime ice increases drag and stalling speed.

Beads of ice can form over the heads of skin rivets.

sure conditions directly affect ice formation; so a review of meteorological instruction courses should be made for a complete basic understanding of ice-formation theories. It must be remembered that the outside air temperature is not the criterion for icing temperatures in the induction system. The limiting factor is the temperature within the induction system itself, and this temperature is dependent upon air pressure differentials which result from the venturi effect of the system.

In a jet-engine, the air is drawn into the induction system by the compressor, or rammed into it by the high speed of the aircraft in flight. Under either condition, the air in the induction system is cooled by the drop in atmospheric pressure taking place. Without an adequate temperature indication in the induction system it is possible to produce ice in the induction system and not know it when outside air temperatures are slightly higher than the freezing point.

Potential ice development is most prevalent in the axial flow type jet engine. The centrifugal flow engine can develop ice on its screens sufficient to cause a loss of power, and damage the engine, but its design renders the centrifugal flow engine less susceptible to ice formation. The air in a centrifugal flow type compressor enters a plenum chamber and slows down, entering the compressor through relatively large intake screens, therefore it does not experience as great a change in pressure and velocity across the screens. Consequently, the necessary ice formation conditions are not as readily produced and ice is not as likely to form.

The rate of ice accretion in the jet engine induction system is dependent upon the amount of moisture in the air and quantity of air passing into the intake system. This, in turn, is dependent upon the turbine speed and the flight speed of the aircraft.

Data Gathered

The following data were taken at one Air Force Base during ground run-up when ice was experienced on a centrifugal flow engine. It must be kept in mind that these tests were taken in the static condition and do not necessarily reflect actual conditions of flight. However, it does serve to illustrate effect of power settings. Data were taken during three different temperature and relative humidity conditions:

- Temperature 21° F, dew point 17, humidity 83%.
  - a. Thick ice on inlet screens at all engine speeds.
- Temperature 22° F, dew point 21, humidity 94%.
  - a. 2 minutes operation at 80%, no ice.
  - b. 2 minutes operation at 85%, no ice.
  - c. 2 minutes operation at 90%, light ice formations.
  - d. 2 minutes operation at 95%, thick ice formations on engine screens and accessories.
- Temperature 23° F, dew point 22, humidity 96%.
  - a. 2 minutes at 90%, no ice.
  - b. 2 minutes at 95%, light ice on engine screens.

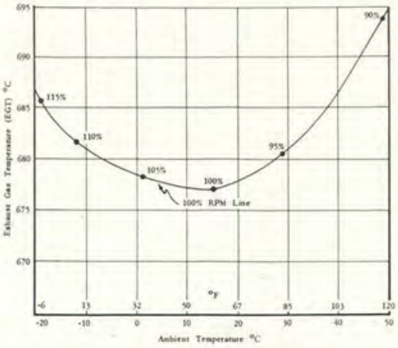
Ice would not form when temperatures were from 24° F to 28° F, dew point from 22 to 27 and humidity from 84% to 96%.

Unlike a reciprocating engine the jet engine consumes large quantities of air in excess of that needed for combustion. This excess air is needed to cool the burning gases to a temperature that the turbine can withstand. As ice forms, the total pressure at the compressor inlet is reduced. This loss in pressure results in decreased mass flow and consequently thrust, and is accompanied by an increase in turbine temperature that partially compensates for the loss of thrust. If the amount of fuel metered to the engine is not reduced, the temperatures in the hot section of the engine will rise until destruction of the engine may result.

It has been established by tests that ice formation in the induction system parts other than on the screen and inlet guide vanes has little effect on engine performance. However, the formation of ice on other component parts in the air-inlet area may, upon breaking off, damage the compressor section when passing into it or cause a blowout.

Throughout the fall and winter seasons, the atmospheric phenomena producing ice is going to be more prevalent than in warmer months because temperature conditions are more conducive to ice formation. Cold weather increases engine output performance, and as a result, loss of power from initial formation of ice may not be immediately discerned on a take-off. When exhaust gas temperatures are normal, about 680° C, engine rpm

100%, ambient air temperature 32° F, the power output is 5% above rated maximum power. Consequently, a loss of power from ice formation of at least 5% or more, would have to be effected before it would ordinarily be detected. As a precaution, engine rpm and exhaust gas temperature curves in the engine operating manuals should be consulted frequently for normal power output during winter months operations.



EGT VS AMBIENT TEMP. (S.L. Static) 100% RPM

This curve is typical of an engine whose jet nozzle is set for rated EGT of 677° at 15°C ambient std. temp. Its shape is representative for other EGT settings at 15°C ambient.

Test Methods

From tests, it was found that ice in the induction system of jet engines could be eliminated by various means. Among the methods tested were surface heating by hot compressor air or continuous electrical heating, and injection of alcohol. Surface heating proved successful when applied to inlet guide vanes and island fairings, but heating of inlet screens has not yet proven to be practical. Research on inlet screen anti-icing is continuing. Northrup has reported some success with use of an ice indicator and alcohol injection on F-89 type aircraft. Weight factors, adaptability, cost, and other criteria are considered in determining which method is most feasible. General Electric has adopted the method using compressor bleed-air and retractable screens, with variations of continuous heat application, and automatic heat when needed. Newer Allison engines also incorporate a retractable screen with the use of automatic heat applications from compressor bleed-air.

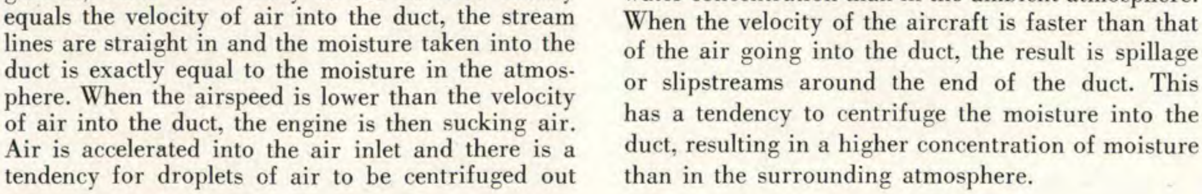
The use of compressor bleed-air is a natural application for the axial flow engine. Compressor air is heated to over 350° F from an ambient air temperature of 60° F under normal operation. This is more than ample to eliminate icing. The bleed air is used to heat and give complete anti-icing protection to the inlet guide vanes, island fairings, and strut jackets.

The removal of screens in axial flow engines is an approved procedure for eliminating icing hazards in winter operations for those aircraft not equipped with inlet anti-icing. Screen removal (Ref. T.O. 01-1-469) is left up to the local commanders' discretion since the added hazard of compressor damage from runway foreign particles has to be weighed against the possibility of icing.

For aircraft equipped with anti-icing systems, protection consists of (1) retractable compressor inlet screens, and (2) hot air already bled from the compressor. The compressor air is used for partially counteracting the thrust load on the #2 bearing and is passed through hollow inlet guide vanes and special manifolding on the front of the forward frame struts. Thus the guide vanes and struts are adequately protected with no loss in performance. This protection is continuous whether icing conditions are encountered or not.

Additional compressor air is bled and led through special manifolds on the island fairings. Provisions are made for using this same air to heat the accessory cover (bullet nose). Island fairings and the accessory cover are heated only when icing conditions are encountered since the additional air extraction does result in some small loss in thrust (1-2%). This sys-

Airspeed vs. Icing



Diagrams show effect of airspeed on icing. In general, when the velocity of the aircraft exactly equals the velocity of air into the duct, the stream lines are straight in and the moisture taken into the duct is exactly equal to the moisture in the atmosphere. When the airspeed is lower than the velocity of air into the duct, the engine is then sucking air. Air is accelerated into the air inlet and there is a tendency for droplets of air to be centrifuged out of the air exterior of the duct. The result is a lower water concentration than in the ambient atmosphere. When the velocity of the aircraft is faster than that of the air going into the duct, the result is spillage or slipstreams around the end of the duct. This has a tendency to centrifuge the moisture into the duct, resulting in a higher concentration of moisture than in the surrounding atmosphere.

tem may be turned on and off by means of a solenoid operated valve which will fail safe in the "open" (on) position in the event of electrical failure.

Learn the Facts

The facts of jet engine ice formation should be learned and respected, however, there is no reason to fear engine icing provided operating personnel understand its symptoms and effects, and plan accordingly. Meteorological information should always be studied for flight-planning and ground run-up to determine where conditions may be expected which are conducive to engine icing.

When icing conditions are encountered, ice should not be allowed to build up in the induction system of those aircraft equipped with manually operated anti-icing devices. When the anti-icing device is turned on after the ice has built up there is a possibility of large pieces breaking loose and damaging the compressor rotor and stator blades or causing blowout. Screens should be retracted before ice forms and prevents retraction. Particular caution should be used during landing approach where ice formation may result in loss of power and excessive tail pipe temperatures in case of a go-around.

For those aircraft not equipped with engine anti-icing devices the following procedures should be considered. Immediately upon recognizing the indications of engine icing—increased tail pipe temperature and loss of thrust—while flying in clouds or air with high relative humidity and low temperature (plus 5° F to plus 32° F) the pilot should retard the throttle, reduce airspeed, and get out of the icing area. Fuel flow variations should not be used to detect jet engine icing since transient contradictory signals are sent to the main fuel control during ice accretion. If the icing area is a cloud entered from below, descend immediately while reducing throttle. If the cloud was entered horizontally, make a 180° turn while retarding the throttle and reducing airspeed. If the cloud layer is thin stratus, attempt to climb and get above the cloud while reducing throttle and airspeed.

Leaving the icing area is the only method possible for eliminating inlet screen and guide vane icing in aircraft equipped with non-retractable inlet screens and not provided with screen anti-icing.

When engine icing has progressed far enough to cause an excessive tailpipe temperature and loss of thrust followed by an explosion and flame-out, an attempt to air restart could result in more explosions or fire.

To illustrate the symptoms of jet engine icing one F-84 pilot who encountered engine inlet screen icing in flight is quoted:

"I was climbing in formation somewhere between 11 and 13,000 feet. At the time, I checked my airspeed at about 215 MPH. I was also looking at the tailpipe temperature and noticed it going up slowly and steadily, so I cut back power to about 80%, shoved the nose down and regained airspeed of 300 trying to stay on heading. I climbed out of the cloud at about 15,000 feet after I regained my airspeed and then increased the throttle setting to 90%. My tailpipe temperature had gone up too high. It went up to between 775 and 800 degrees before I cut back the power. I encountered no further trouble and returned to base."

Another F-84 pilot in the same flight gave this account of what happened:

"After we entered the cloud I lost contact with my flight leader in front of me. Immediately after that I had a flame-out. My fire warning and overhead lights came on and my tailpipe temperature went up and hit the peg. I also had at the same time —I don't know whether you would classify it as an explosion—but it was the same type of sound you have when you change from your normal fuel system to your emergency. I slowed my airplane down to approximately 240 MPH. When my rpm reached approximately 18%, I switched to alternate and tried an air start. As soon as I opened my throttle up, I had a fire warning light go on and overheat light with 1000 degrees tailpipe temperature."

This pilot was forced to eject.

Whether you are flying an aircraft with or without anti-icing equipment, know what to do when you meet icing conditions. Don't be caught unexpectedly. Plan your flight to avoid the ice, when possible, or if you have anti-icing equipment, "anti-up" before you enter the icing area. ●

Preflight and refueling operations can sometimes be a chilly-but-not-rushed affair during winter operations. The pilot should watch for ice during his ground run-up and taxi with more than usual caution.

WINTER CHECKLIST FOR THE PILOT

Here is a winter checklist that will help take the hazard out of cold weather flying:

Check weather carefully. Ask the pilot who just came through.

Remove frost and snow before takeoff.

Check controls for restrictions of movement.

fter run-up in fog or rain, check ing and empennage for ice in pro-eller blast area.

Don't take off in slush or wet snow if it can possibly be avoided.

Use pitot heater when flying in rain, snow or clouds, as well as known icing zones.

Remember when ice forms you will use more fuel to get to destination.

Ice on the airplane causes increased drag, and all types of ice prevention measures take work away from the airplane that would normally go into the cruise range of the airplane, whether it be heat or boots. Therefore, if icing conditions are anticipated, a more conservative cruise control also must be anticipated.

If flying in wet snow or freezing rain, change altitude if possible.

Use propeller de-icers just before getting into ice.

Use full carburetor heat to clear ice. (Use carburetor preheat for prevention. Don't wait to cure.) Watch your carburetor air temperature, especially between -5° and 10° C (23° and 50° F.).

Watch your airspeed — stalling speed increases with ice—Don't climb at a low airspeed.

Check wing de-icers — Use them properly. Do not land with de-icers on. They act as spoilers.

If you have a load of ice, don't make steep turns.

Don't try three-point landings, if iced-up. Fly in with power. Before starting landing approach, move throttle back and forth slowly to make sure carburetor butterfly is free of ice.

Carry carburetor heat during final approach and change to cold just before flareout.

Before take off check anti-icing and de-icing equipment. Be sure it is in good operating condition. You might need all of your equipment. ●

Safety Tips for Winter Operations

There is often a thin coat of ice under the fluffy blanket of snow which has accumulated on the wings of your plane. Don't depend on the snow blowing off during takeoff, even the light kind, and check for ice. Falling snow sticks at temperatures above 10° F. It also forms a coat of ice between 32 and minus 10° F.

Snow-grip tires should be on all aircraft flying into icy runway country. Even the best brakes will not stop an aircraft that is skidding down an icy runway. Every winter there are a few accidents of this nature which could have been prevented. The heavier transports seem to be especially addicted to the long skid when not properly equipped.

Snow or ice covered runways require that short field landing techniques be employed at all times since braking action is at a minimum. Instead of landing short, the common tendency, due to optical illusion, is to land long.

Propeller pitch should be changed occasionally during cruise, to prevent oil congealing.

Cold, and the necessity of wearing heavy flying equipment tends to lower pilot efficiency. The physiologists say that many of the same symptoms which are associated with hypoxia have been noticed in pilots who are subjected to extreme cold. However, this is not dangerous, just a matter of expecting it and being a little more alert than usual.

There is no way accurately to estimate the number of inches of snow on a runway. If an airport is not being used, stay away from it, unless you have an emergency. One pilot "estimated" that there were two inches and landed on his back. There was an airport with cleared runways not far away.

Night takeoff accidents involving loss of directional control and collision with snow-banks point up the necessity for being really on your toes under these conditions. A slight veering to the left would ordinarily not be noticed but when there is a snow-bank in that direction the veer winds up as an accident statistic. ●

A pilot should learn more about some of the techniques that the weatherman uses to obtain a forecast. In this way the pilot will know the limitations of the forecast and will build confidence in his own decisions as to the safest routes and altitudes to fly in difficult weather

Winter

Knowing what to expect in the way of weather can do much to make your winter flight a safe one.

WHEN THE pilot walks into the weather office, there are three things he should be thinking about:

• Getting and keeping in mind a complete picture of the current weather situation.

• Moving the picture forward in space and time to cover the route of the flight.

• Considering the changes that will occur during the entire trip.

The map displays much information in a pictorial manner, and a brief survey of it, with the help of the forecaster, will show in a few moments what it would take hours to describe. This is particularly true when a flight is planned in rapidly changing winter weather.

The freezing level may change radically within a short period of time or over a short distance because of the change of air masses associated with frontal passages over various stations or in flying through a front. This may usually be checked by finding the freezing level within each air mass over stations and considering the past movement of fronts and the approximate point at which the plane will fly out of one air mass and into another.

Low ceilings and visibilities are winter bugaboos which all pilots must face, but they can be forecast. They are due, primarily to two factors. First, the presence of a slow-moving warm or occluded front with precipitation ahead of it will bring the ceiling down and lower the visibility until zero-zero conditions are the rule throughout a wide area.

Upslope fog is formed when air is lifted by prevailing winds up the slopes of mountains. Advection fog is formed when warm moist air moves over a colder surface. This fog may persist during the day, but usually will become low stratus with ceilings of 100 to 500 feet during the day and, with sufficient heating, may break in the afternoon and form again about sunset. Forecasting this formation and dissipation may be tricky. A pilot should be sure he has an open alternate before flying into a doubtful area.

Another Problem

Another winter problem, which may have been forgotten during the summer months, is the effect on a pressure altimeter of the changes in reading caused by flights into areas of different pressures or flights into cold air.

Remember that the altimeter will read too high—causing an altimeter reading which shows a higher altitude level than that of the plane—when flying from higher toward lower pressures.

Regarding winter flying, the month of October is usually looked upon as the prelude of things to come. While October is considered a fall month, in some sections it often is marked by very poor flying weather.

This is particularly true in the Far Northwest, where October brings fogs and low ceilings. In the Seattle area, for example, visibility averages between 0 and 1 mile, 37 per cent of the time during the hours of 0300 to 0900, but improves noticeably during the hours of 1200 to 1800.

October also ranks as a very poor flying month along the California coast, with the chances of heavy fog and low ceilings greater than any other month. In the middle west plains states, October brings a few active cold fronts, one or two active lows and a tendency toward ground fog formation during the sunrise period. The average height of the freezing level comes down to about 12,000 feet.

Weather

Read the Weather!

No one expects the average Air Force pilot to become a weather expert, but every pilot should be able to read a weather map intelligently.

In addition to studying the weather forecasts for his route, the good pilot will study the synoptic situation on the weather map, noting especially the frontal weather where the most dangerous icing is usually found. Temperatures near or below freezing and the presence of moisture are the two things to look for, because they are both needed to get icing conditions.

The Central East coast during October has alternating periods of stable, fog-laden air when highs become stranded off the coast, in addition to general rain and low ceilings.

In November, dark, rainy weather is typical throughout all of the Northwest. Interior areas see almost as much wet, foggy weather as the coastal sections. West of the Cascades, November ranks as the worst flying month of the year because of heavy snowfall in the mountains. The average height of the freezing level is down to about 7,000 feet toward the end of the month.

Best Weather

The Las Vegas area has the finest weather in November but the rest of the southwest is exposed to the first winter types of frontal and airmass weather. The rainy season is generally well established by early November. Average height of the freezing level is down to about 8,500 in the northern section and 10,000 in the southern section.

The instability effect is stronger during November around the Great Lakes, as cold masses of Canadian air move in across the warmer waters. The entire area has frequent blankets of stratocumulus clouds with accompanying snow squalls.

The East coast, unlike the West coast, has a more gradual approach to the bad weather peak which comes in late December and January. Lowering of the freezing level to around 5,000 feet, plus lack of good alternates in the area, makes November relatively bad, weather-wise.

Although major storms are possible and highly probable anywhere in the country, the Northwest and Northeast sections catch the brunt of bad weather during December. The eastern storms are more likely to create widespread low ceilings and fog. The east slope of the Rockies usually provides the best weather in December, because strong downslope winds prevail for a week or more at a time.

The interior valleys of California offer the most consistent stretches of bad weather, as fog is often continuous for days at a time, interrupted only briefly by slight lifting during the afternoons.

January is the worst flying weather month of the year, considering the winter as a whole. Storm developments reach their peak of frequency and intensity, cold ground surfaces provide ideal conditions for fog formation, and airmass contrasts between ocean and continent are at a maximum.

The entire Northwest offers a continuation of the December pattern, while the east slope of the Rockies again has the best flying weather due to the strong, westerly, downslope winds. January is the wettest month along most of the California coast, Chambers of Commerce notwithstanding. Fog is concentrated more heavily in the central valleys, but Nellis AFB or Edwards AFB are practically 100 per cent clear, and may be used as alternates.

The Great Lakes and East Coast areas are particularly poor for flying during January. A high proportion of low ceiling and visibility occurs in connection with warm fronts lying to the south of the areas over the Carolinas or just off the coast.

Generally speaking, winter weather presents hazards not normally found during other seasons—however, the pilot who gets a good weather briefing and prepares himself for winter flight should encounter no weather problems which he can't handle. ●

Snow covered runways are always a hazard for landings. Below, a smart pilot gets a "picture" of the weather

Weather in

Three are company, not a crowd — in flying the arctic

Fuel is doubly important when pilots prepare for a long flight over frozen terrain within a few miles of the North Pole.

CONTRARY to what many people may think, weather in Alaska or other parts of the Far North is not always icy. It is, of course, a good bit colder for most of the year than a place like Texas, for example, or Florida. And since it is with this colder season that we are here concerned, no mention will be made of the record high of 100 degrees in the shade which was set at Ft. Yukon, Alaska, a few short years ago.

Although temperatures vary considerably in northern regions, generally speaking, the interior area has the coldest winters and the warmest summers. The sub-polar coastal area has warmer winters and cooler summers because the large bodies of water there stabilize the temperatures. The polar region is quite cold the year around.

Precipitation

Precipitation is usually relatively light in the polar area. Approximately half of this appears as snow. The low precipitation rate is chiefly due to the fact that the air is constantly at a low temperature and therefore cannot hold much moisture.

Also, most bodies of water are covered with ice a good part of the year and this prevents the normal evaporation process of an ice-free ocean.

Winds

One region of the Far North in which the wind is particularly severe is the Aleutian Chain. The chain is on the main storm track and often has wind velocities in excess of 100 miles per hour.

In sub-polar coastal regions, winds are often severe without regard to season. There is great variation in the direction and intensity because of varying exposures and terrain features. Gales are most severe in fall, winter and early spring.

All seasons tend to be moderately windy over the polar ice-pack, while the sub-polar interior regions suffer the least from winds.

The most important effect of wind in the Far North is its acceleration

the Arctic

when you're flying in the polar regions you had better be prepared for the extremes of wind, fog and cold

of the rate of cooling. A term has been coined to describe this combined cooling effect of winds and temperature—wind-chill.

Fog

A weather phenomenon of great importance to flying operations in the Far North is fog. The most common type, as in most of the other areas of the world, is coastal fog. This usually lies in a bolt parallel to the shore. In winter months, the sea is considerably warmer than the land, which cools rapidly, and warm moist air moving from the sea condenses over the cool land, with fog resulting.

In the Aleutians, the principal fog is the type which forms over water and is blown in by the wind. These fogs are usually of considerable depth and they remain on the surface until air turbulence tends to raise them into a high fog or low stratus.

The most common types of polar fogs during the winter months are ice fogs and spicule. The latter is formed by extremely fine ice crystals and is a kind of snowfall that results from condensation during cloudless periods of low temperatures, high humidity and calm or mild winds. When it obscures the ground, flying operations can become extremely dangerous. This fog is characteristic of the Greenland ice pack.

Another type of ice-fog is one which may occur in any area subjected to extremely low temperatures but is peculiar to the northern interior regions. Ice fog is composed of very small ice crystals formed by sublimation. It can be very dense, in which case it takes on the appearance of any other fog.

Ice-fog can also be caused by moisture in the air as a result of the presence of a large number of people, animals or moisture producing installations. This is the type of fog which is caused by the jet blast of airplanes and causes visibility to be extremely restricted around air bases during jet operations, making landings and takeoffs hazardous until it burns off. ●

Cold winds stir up dry snow on plateaus and sweep clear jagged arctic peaks

If you know how to cope with winter's tricks you need have no qualms about the cold.

Ground Rules

THERE IS a story, known to most Air Force pilots, of the Arctic flyer who landed on an ice cap without knowing it. In zero visibility, with the wind howling about the aircraft making it rock and vibrate as though it were in flight, the pilot sat for several minutes before he or one of his crewmembers finally discovered that the plane had actually touched down and slid to a stop on its fuselage. The story may seem a bit on the fantastic side, and perhaps it is. But the point of it all is that flight operations in the Arctic or in snow and ice covered areas is an entirely different thing from operations in the warm, sunny southland.

One source of many winter accidents is taxiing on snow or ice covered surfaces. There is a definite technique to this phase of operations, which can best be learned by actual practice. Slippery surfaces greatly reduce the effectiveness of brakes in steering or stopping. All taxiing must be accomplished with this in mind. Pilots of multi-engine planes should use power almost exclusively in their taxiing, yet they must not use so much as to start a turn which, without brakes, cannot be stopped.

Taxi Safely

Few commanders will require that a pilot taxi his plane when in his opinion it is unsafe to do so. Any time the pilot feels it is hazardous to taxi, whether it be because of slippery surfaces or any other reason, it is not only his right but also his responsibility to stop the plane and call for a tug.

REVIEW YOUR RULES

About this time of the year all pilots should give a thought to winter's peculiar demands on the pilot. Most winter flying rules were gained through someone's "hard-way" experiences; some, of course, were developed strictly from common-sense-style reasoning—then proved when stubborn or unknowing pilots strayed from the straight and narrow.

Presented here are only a few of the winter rules for flight with safety. There are many more, some of which apply only to particular localities.

Until a more satisfactory method of snow disposal is found, snowbanks probably will remain a problem and the obvious recourse is for pilots to remain ever alert to their presence. Some tips regarding snow banks: Be particularly alert to the snowbank danger at night and use lights at all times for taxiing. When parking, be careful about making turns and ascertain that there is sufficient clearance before swinging the tail around. Also, when turning into position for engine run-up prior to taking the runway for takeoff, make sure that there are no snowbanks at the end of the runway or on the taxi strip which your tail may strike. Another but very important job of each pilot should be to accept the responsibility for doing all possible to lessen the snowbank hazard. Whenever a snowbank situation is noticed which is considered conducive to accidents, report it and suggest a way of removing or lessening the hazard.

There are many instances each year of airplanes being damaged when wheels and prop blast throw ice against flaps, wheel-well doors and other skin surfaces during landings and takeoffs. Also, slush may be thrown into the wheel wells, then freeze so that the landing gear cannot be lowered for the next landing. The solution lies in avoiding takeoffs and landings from slush-covered surfaces whenever possible. If a takeoff

for Winter

There are many angles to winter flying—it involves hazards found at no other time

must be made, move the landing gear through a minimum of one complete cycle after the climb has been established.

Along with the usual visual check of an airplane prior to takeoff, a thorough inspection should be made for frost, ice or snow on wings, fuselage, tail surfaces and propellers. What makes it so important to remove every trace of these substances is not so much the weight, but rather the additional drag induced by the rough surfaces. This drag can easily alter the flight characteristics of the airplane, and the critical time just as the plane becomes airborne is no time for a change in airplane characteristics. In fact, the change in airfoil configuration may be so drastic when wings or tail surfaces are covered with ice or snow that the plane may not even get off the ground.

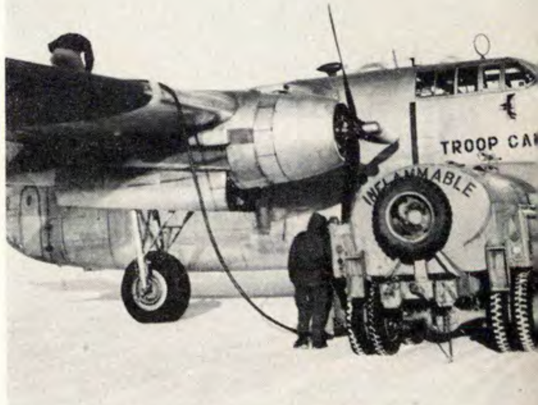
Check Controls

A usual part of the pre-takeoff check is to insure that controls move freely and properly. In winter, especially after precipitation, this check is particularly important. Light snow can sift into the smallest openings and either freeze the controls in one position or become packed so that movement may later be restricted. Wherever possible, all openings for aileron and elevator hinges, trim tabs, etc., should be visually checked, then checked again just prior to takeoff by insuring that full control movement is available.

Probably an even more critical phase of flight when runways are covered or patched with snow and ice is the landing. Before clearing for another field during winter months, check NOTAMS to make sure that runways are open at your destination. Twenty-four hours, or even less can make a very great difference in field conditions.

Once over your destination, remember that when the ground is snow-covered, depth perception suffers. Lack of contrast between the runway and the surrounding areas may cause the runway to disappear from sight entirely on the final approach even though it was clearly visible from directly overhead. A good practice whenever ice, fog or snow flurries are present is to ask for the runway lights to be turned up to full intensity. The lights will help in judging height above the runway and at the same time will help you to keep oriented in the traffic pattern. A pair of sun glasses are almost a must when sun glare off the white snow reflects into the pilot's eyes. Such a condition can affect depth-perception to the point where the pilot may either stall out high above the runway or dive into the ground. When glare, fog or snow flurries are really bad, assistance should be requested from GCA if it is available. ●

A fireguard is a good rule in any weather — particularly during refueling.



JET LETDOWNS

At the end of an IFR Flight with fuel supply low, the jet pilot's big concern is getting down fast.

IN ORDER to standardize instrument approach procedures, the USAF, U.S. Navy, U.S. Coast Guard, and the Civil Aeronautics Administration published ANC Manual, subject, "Criteria for Standard Instrument Approach Procedures." AFR 55-24 requires the use of this ANC Manual in establishing instrument approach procedures.

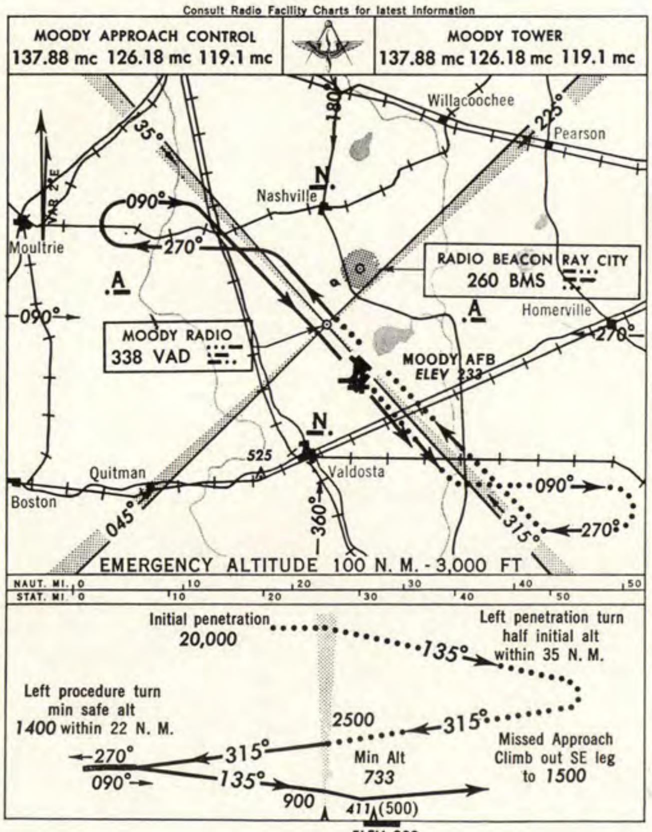
The primary purpose in the establishment of the jet letdowns was to permit jet aircraft to accomplish penetration and standard instrument approaches with the least possible delay in time and the minimum number of turns. These jet penetration procedures are established so as to provide the least interference with conventional type aircraft, and to provide for the accomplishment of jet letdowns when conventional aircraft are held on the primary fix where jet aircraft is executing letdown. The following criteria for jet penetration and approach has been extracted from ANC Manual, subject, "Criteria for Standard Instrument Approaches," published 1 October 1951. The diagrams shown are typical examples of combining jet penetration and standard instrument approaches. In most all cases the low cone altitude and the procedure turn altitude published in the jet instrument procedure is identical to the standard range approach. Standard Jet Penetration Procedure:

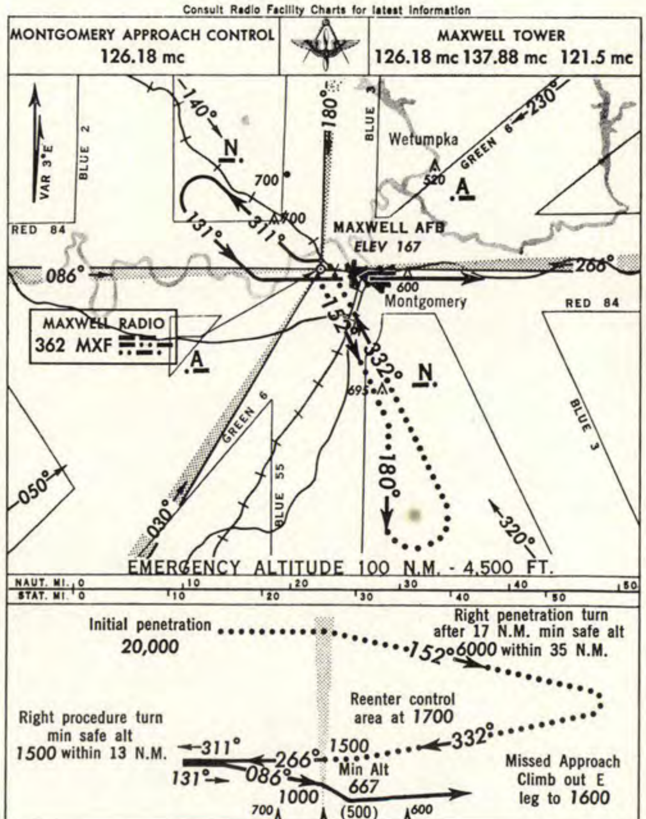
• *Initial penetration altitude.* The altitude at which aircraft crosses radio facility for beginning penetration procedures. This altitude will be established for each procedure and will normally be specified as 20,000 feet M.S.L.

• *Penetration turn.* A one and one-half degree per second turn made during the jet penetration procedure to return the aircraft to an inbound heading to the radio facility being used for the penetration. The penetration turn is normally a flat turn, however, if a descending turn is used, indication will be given in the procedure.

• *Minimum penetration altitude.* The minimum altitude for the jet penetration procedure to an airport will be the initial approach altitude for the standard instrument approach procedure.

• *Initial approach altitude.* The initial approach altitude will normally be as shown for the stand-





ard instrument approach procedure. Where no initial approach altitudes have been established, a clearance of at least 1,000 feet above all obstructions within a radius of ten miles of the radio facility and ten miles to either side of all penetration courses within an open quadrant for a distance of 40 miles from the radio facility must be provided, except in mountainous areas. In all parts of the United States and Canada designated as mountainous areas, a clearance of at least 2,000 feet must be provided.

• *Procedure turn.* As shown in the standard instrument letdown criteria.

• *Emergency altitude.* Will clear all obstructions within a radius of 100 nautical miles of the radio facility by 1,000 feet, except in mountainous areas. In mountainous areas the clearance will be 2,000 feet.

Procedures: Jet penetration procedures may be established as one of the following types:

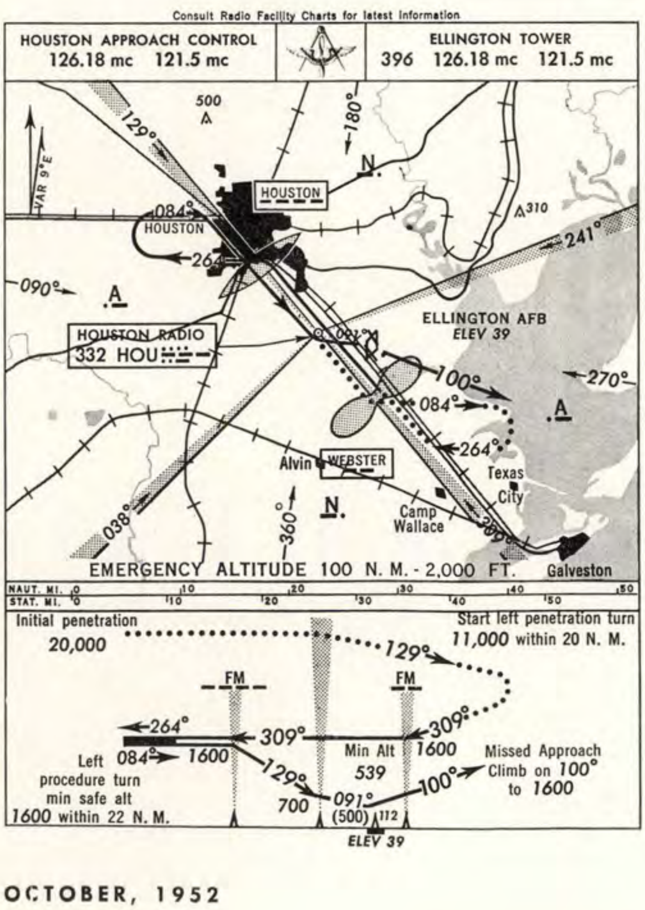
Standard Penetration: Normally, standard penetration procedure will start over the radio facility upon which the standard letdown is based at initial penetration altitude. The penetration procedure will be established in the direction from the radio facility which is most acceptable, dependent upon traffic and terrain features.

Penetration is started at a specified rate of descent and a specified airspeed when over the radio facility or at a given distance after passing the radio facility and is continued until initial approach altitude for the jet procedure is reached. The penetration turn is started normally when one-half of the difference between initial penetration altitude and initial approach altitude is lost.

When the penetration turn is complete, the aircraft will either home on the radio facility or intercept a specified range course, dependent upon procedure. In either case, the initial approach altitude must be reached before arrival at the radio facility. The penetration procedure will terminate over the radio facility upon which the procedure is based at the initial approach altitude.

If visual contact is not established upon reaching the minimum penetration altitude for the jet procedure when over the radio facility, then a straight-in approach to the airport may be started, providing the descent to the authorized minimum altitude involves no vertical rate of descent in excess of five hundred (500) feet per minute. Should the foregoing not be practical, a standard instrument letdown procedure will be executed.

En route penetration. En route penetration to an airport may be approved. These penetrations will be started from primary fixes normally located not more than 100 miles from the radio facility serving the airport for which letdown is planned. En route penetration procedures will terminate over the radio facility upon which the standard letdown procedure is based at the initial approach altitude. If visual contact is not established over the radio facility at minimum penetration altitude, the pilot normally will start a standard instrument letdown or continue his approach under CGA. ●



If you're rusty . . . then bone up on your jet procedures.

Don't Bend the Wings

On some bases a few aircraft attain an attitude opposite to that of a parked B-47. These are T-6's, T-28's and T-33's with a new twist—wings bent upwards. They are not new models but overstressed standard aircraft with form 1's reading, "Wing cracked at station 32," "Wing cracked at station 20," etc. They cost a lot of money, training time, repair manhours and in some cases are a direct drain on the production line for they are so *badly* cracked at wing stations that they make the long trip back to the factory.

The common rebuttal of the pilots who cracked the wings is "I didn't blackout," meaning it was all right as long as you didn't blackout. You don't have to blackout to pull excessive "G" 's. Sample: Two air cadets do three split S's with sharp pullouts in a T-28. Result: Ten positive G's and a lot of repair and training time lost. They didn't blackout, but they did overstress the aircraft.

Blackout occurs only if G's are severe enough and *sustained over a period of time necessary to remove oxygenated blood from the head*, the cause of blackout. This process takes some time, admittedly not a great amount of time, but much longer than the amount required to bend those wings during abrupt application of G forces. Remember that you can register three G's easily on a T-33 in rough air just by skipping along like a flat rock over the water. That doesn't black you out does it? You get a little better than fourteen G's in ejecting from an aircraft with a 37 mm shell propelling you from a standing start and that doesn't black you out. I know, for I've done it. The big secret is the time element during which these G's are applied.

Some instructors are guilty of telling the student pilot that "if you don't blackout, you haven't pulled too many G's for the aircraft." For the benefit of all pilots, you *can* pull too many G's for the aircraft with or without a "G suit" and *without* blacking out. The "G suit" increases *your* "G tolerance" only, whereas the aircraft stress limits remain the same depending on its load.

—T/Sgt Perry W. McGlynn,
3560th Medical Group
Webb AFB, Texas

Eject With Hose

Here's a suggested technique for rerouting and connecting the headset and microphone cord on P-1 helmets. Since the oxygen hose and radio cord are used simultaneously, it would seem convenient and advantageous to combine them in a single connector.

Two more suggestions are: Place the hose clip on the mask side of the disconnect so that it will be less likely to be floating around, in case of a bailout; and, as a future modification, put the pilot's oxygen hose plug into a part of the ejection seat so that it will remain securely fastened during ejection and be one less concern of the pilot during bailout.

—2/Lt Bruce W. Mack
80th Ftr-Bmr Sq, APO 970

The suggestions are being passed on. Future aircraft equipped with ejection seats will have the pilot's oxygen hose plugged into the seat.

Clarification

Are the items described in *Crossfeed* articles to be considered as accepted and approved by the USAF? Does AMC sanction the improvisations suggested and printed?

Everyone I have asked has a different idea as to whether or not publication in FLYING SAFETY magazine automatically puts a stamp of approval on suggested projects or not.

—Lt. Col. Stanley V. Rush
111th Ftr. Intcep. Sq.,
Houston, Texas

The contents of Crossfeed are informational and should not be construed as regulations, T.O.'s, or directives unless so stated; nor does publication mean a USAF stamp of approval. Crossfeed is a department wherein you may voice your comments and ideas on flying safety topics.

Well Done Twice!

Capt. Walter K. Davis

This month we have two "Well Dones" which are so similar, everything is identical except the names of the crew-members concerned. Shortly after completing the artwork for Lt. Campbell's "Well Done," Flying Safety received the following account of precision flying on the part of Capt. Walter K. Davis. Our congratulations go to Captain Davis of the 580th Air Resupply Squadron, 580th Air Resupply and Communications Wing, for a job well done.

At 0850 hours, 7 July 1952, Capt. Davis, in his C-119, advanced the throttles for what was to become a very "un-normal" takeoff from Idaho Falls Airport. As he became airborne, he lost complete elevator control. Complete travel fore and aft of the control column produced no change in the pitch attitude of the aircraft.

Quickly appraising the situation, he used the elevator trim tab to provide sufficient pitch control to climb to normal traffic pattern altitude. Here he offered the crew the choice of bailing out or remaining in the aircraft. They chose to stay.

After experimenting with the trim tab and developing his own traffic pattern, Capt. Davis elected to bring his disabled C-119 into Idaho Falls rather than proceed to Mountain Home AFB, his home station, where a

10,000-foot runway was available. He knew that a return flight would place undue strain on the elevator trim tab system, a strain that might mean total loss of control.

Painstaking experimentation resulted in a successful flareout and additional 25 knots above normal approach speed to provide an additional safety factor by keeping the aircraft out of the speed range where control response might be sluggish.

An inspection of the aircraft revealed a complete failure of the right hand elevator bell crank and of a left hand push-pull rod, prime movers of the elevator flight tab control surface.

This is another instance where thorough knowledge of his aircraft enabled the pilot to prevent a costly accident.

Alert Alerts

There are many things that may aid a pilot in operating his craft in a safe manner. I believe that one of these things is the efficient manner of operation of the Transient Alert Crew and Base Operations sections. With this thought in mind, I would like to throw a salute to the Alert Crews and Base Operation personnel of Castle, McClellan and McChord Air Force Bases.

I have been to the above-named bases on many occasions during the past year. They have always been polite, fast and efficient in servicing my airplane, and in aiding me on any other matters pertaining to my flight. Normally, these bases will have an F-80 serviced and ready to go before the pilot can check the weather and fill out a new clearance.

—Capt William F. McCrystal Jr
Asst Director
Academic Training
Nellis AFB, Nevada

The original art used for the Well Done feature each month is mailed to the individual concerned. Along with the art goes a letter of commendation for his 201 file from the Director of Flight Safety Research.

KEEP CURRENT

Lower Landing Speeds

Research has shown that an important factor in the maximum lift of a particular wing or flap design is maintaining a smooth flow of air over the surfaces at high airplane angles of attack or large flap deflection angles. Laboratory tests indicate that this smooth flow of air sometimes breaks down because of a slow moving sheet of air next to the wing surface known as the boundary layer. Scientists have found that if this slow moving air can be controlled or removed, smoother flow and hence more lift can be obtained.

With the trend of aircraft design toward more supersonic aircraft, the problem of maintaining sufficient lift during landing is beginning to bother the slide rule specialists. Working to overcome this problem, scientists at the Ames Aeronautical Laboratory, Moffett Field, Calif., currently are conducting tests to reduce landing speeds of high speed aircraft.

These tests are being held in the gigantic wind tunnel at Ames, which is capable of producing wind speeds up to 250 MPH. The tests are under the supervision of scientists of the National Advisory Committee for Aeronautics.

The F-86 is being used for study of air flow conditions on swept-back wings at landing speeds.

Pieces of yarn are attached to the wing and wing control surfaces so that air flow patterns can be observed and photographed while the plane is in the wind tunnel.

In connection with the wind tunnel research program, NACA carries out extensive flight test programs using specially equipped aircraft to obtain data on wind flow patterns and other information relative to the in-flight handling characteristics of various type airfoils.

That New Look

A Lockheed Corporation test pilot displays a new helmet designed by company engineers for its jet jockeys. The plastic helmet which must be formfitted to the individual pilot, has a tinted, plexiglass visor completely masking the pilot's face.

The movable visor can be raised or lowered and locked into place to withstand strong airblasts. A knob on the front of the helmet is used to move and lock the visor. It also filters the glare from ultra-violet rays encountered at high altitudes.

The visor, when locked down, also protects the oxygen mask.

On Blind Flying . . .

Capt. Matthew R. Wilson, School of Aviation Medicine, has come up with two new colors for the plastic shields used in practice instrument flying.

The red-green combination once used by the Air Force was reinvestigated by Capt. Wilson. He found that it had been abandoned mainly because the green used in the canopy shields restricted the observer's vision too much but that the red goggles were ideal, as red efficiently transmits light in the red-orange spectrum.

A new green canopy shield was developed that increased the total transmission of light by approximately ten per cent. Tests were made using the new green against the amber and the red against the blue goggles. The tests confirmed that red is superior to blue for goggles and the new green shield is equal to the amber as a transmitter of light through the canopy.

As soon as the tests are complete the School expects to make an official report to the Air Force, recommending adoption of the red-green filter system.

Sierra Wave Project

Meteorologists at the University of California at Los Angeles currently are working on a wind flow project which should prove to be of great benefit to pilots who fly over mountainous terrain.

Useful flying directives applying to mountainous terrain in general may result from the project. ●

Miss Sonja Henie

you, too, can be an expert on ice!

WHETHER you wear skates on your feet or skis on your airplane, it pays to be an expert. Miss Henie is a professional on ice—a pilot should be, too. But the pilot needs to be a different kind of ice expert. When he takes a fall on ice, the results are usually much more serious. Like many other things, ice doesn't mix too well with flying. However, the two can get along together. All it takes is a pilot who knows his business. And his business includes knowing all about ice.

Be Smart—Expect Ice!

KNOW YOUR GROUND-AIR EMERGENCY CODE

REQUIRE DOCTOR SERIOUS INJURY	REQUIRE MEDICAL SUPPLIES	UNABLE TO PROCEED	REQUIRE FOOD AND WATER	REQUIRE FIREARMS AND AMMO.	INDICATE DIRECTION TO PROCEED	AM GOING IN THIS DIRECTION

WILL ATTEMPT TAKE-OFF	AIRCRAFT BADLY DAMAGED	PROBABLY SAFE TO LAND HERE	ALL WELL	REQUIRE FUEL AND OIL	NO	YES

NOT UNDERSTOOD	REQUIRE ENGINEER	REQUIRE MAP AND COMPASS	REQUIRE SIGNAL LAMP

Take care to form the signals exactly as shown to avoid possible confusion. Check your Radio Data and Flight Information Manual (AN 08-15-2) for these and other type signals.

IF YOU'RE DOWN... MAKE THE SIGNS OF SURVIVAL

Lay out these signs accurately by using: rocks, tree branches, logs. Peel logs and float them on lakes. Dig trenches in sod. Tramp trenches in sand or snow. Use sea marker to dye snow or light sand. Build fences of anything to throw shadow to form the symbols. Endeavor to create the greatest color contrast between signal and background. Make the signals as large as possible . . . at least eight feet high.

Read "Survive in the Arctic" in this Issue of FLYING SAFETY

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