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COLD WEATHER OPERATIONS WITH P-3 AIRCRAFT

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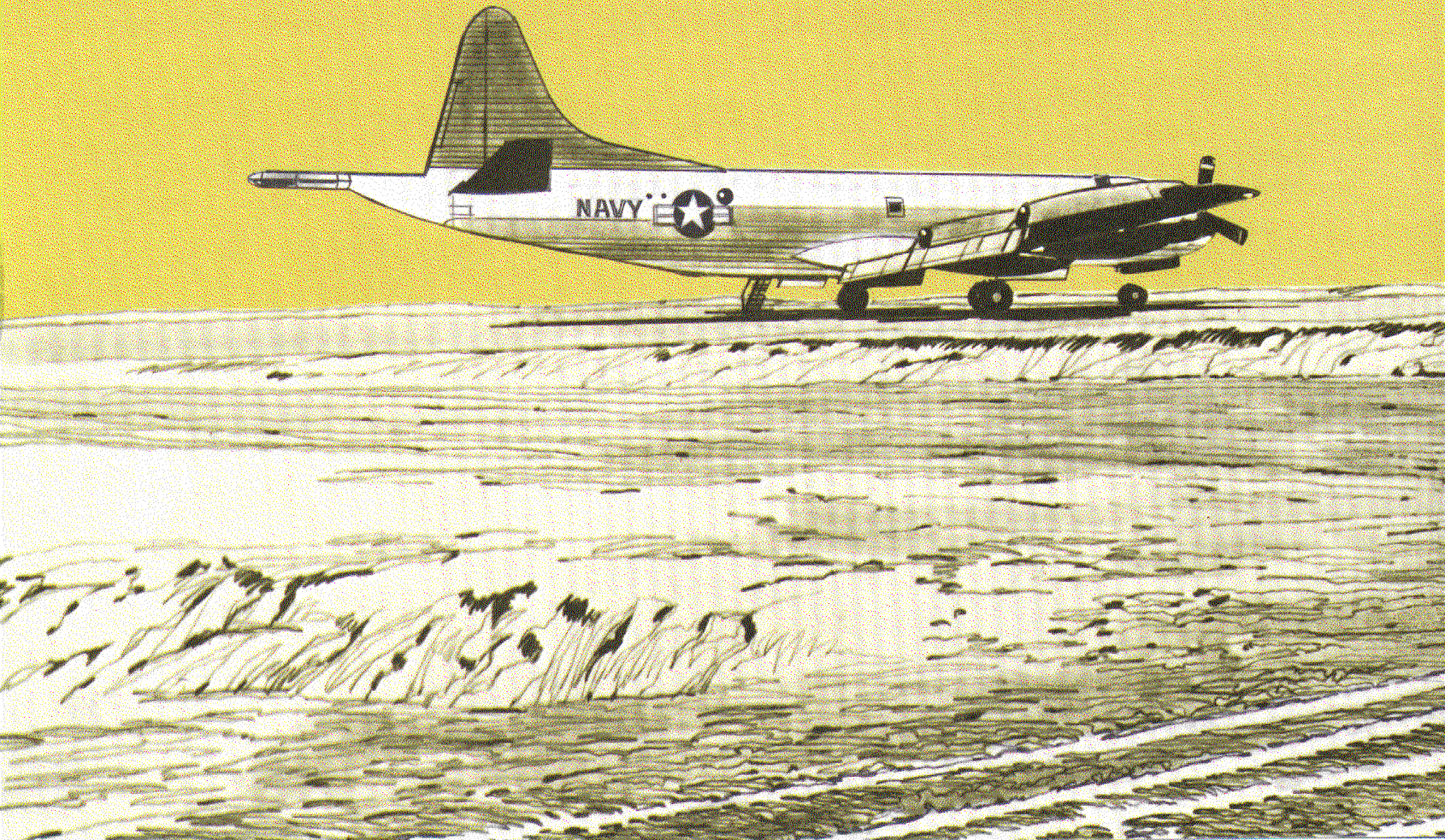
FRONT AND BACK COVERS

Patrol Squadron Sixty-Five was commissioned on 1 November 1979 as part of a major reorganization of the Naval Air Reserve Forces. The squadron was formed along the lines of regular Navy squadrons, with nearly identical organization and manning level. It was made up of the officers and men from four smaller reserve patrol units based at NAS Los Alamitos, California. Two months after its formation, the squadron moved up the California coast to NAS Point Mugu.

Almost immediately after their establishment, VP-65 and the twelve similar reserve patrol squadrons forming across the nation became composites of active duty personnel and the part-time reservists, fondly called "Weekend Warriors." The active duty personnel provide the squadron with training cadre and the continuity of administration and aircraft maintenance in the days between the reservists' drill weekends.



During its history, VP-65 has performed a variety of functions, including its main role of training for combat readiness in case an outbreak occurs that would require the squadron to augment the Fleet forces. The squadron also performs operational assistance for the regular Navy forces during drill weekends and active duty training periods. VP-65 aircrews have operated in support of the Navy forces in the Mediterranean Sea, the Eastern Atlantic and the Pacific Oceans, and in Central and South America.

At its inception, PATRON Sixty-Five had twelve *SP-2H Neptune* long-range patrol aircraft. The Neptune, with two reciprocating engines and two auxiliary jet engines, had long been the Navy's main ASW and patrol aircraft.

After transitioning to the more reliable and better-equipped *Lockheed P-3A Orion* in 1975, the squadron was ordered to the Western Pacific, where it served at Guam and the Philippines in 1976, 1977, and 1978 as the on-station Patrol Squadron Detachment. VP-65's 1979 summer cruise included training and operational missions ranging from the Eastern Atlantic to the Western Pacific. Two crews participated in Southeast Asia Refugee Rescue Operations, while one crew achieved distinction by locating and tracking a foreign national submarine — the squadron's primary mission.

During VP-65's summer 1980 cruise, the squadron operated throughout the Pacific and Eastern Asiatic area, from Japan to Singapore. Secondary staging was headquartered out of NAS Cubi Point, Republic of the Philippines. Missions also were flown deep into the U.S. Trust Territories of the Mariana, Marshall and Caroline Islands.

Patrol Squadron Sixty Five's proficiency and combat readiness has been recognized by receipt of the Noel Davis Trophy, awarded to the Naval Air Reserve's most efficient squadron.

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Cold Weather Operations with P-3 Aircraft

by Stanley J. Olsen, Pilot
Military Flying Operations

FOREWORD

This article on P-3 Cold Weather Operations is not intended to replace the Cold Weather Procedures presentation in the P-3 NATOPS Flight Manual. Rather, it is a synopsis of that material, combined with additional information drawn from a VP-8 presentation on this topic prepared some time ago, Lockheed Ready Room articles, and with actual experiences of the author. Before embarking on a winter cross-country flight, a quick review of this article should sufficiently refresh your mind on P-3 cold weather procedures. The answer to any specific question should be sought from the final authority, the P-3 NATOPS Flight Manual.

Stanley J. Olsen

INTRODUCTION

Now that autumn has rotated away and winter has moved into place, the days are disgustingly short and weather patterns are changing throughout North America. People in most parts of the United States are buying snow tires, chains, antifreeze, long underwear, heavy coats, gloves, boots, and new furnace filters. Pilots and aircrew are going over their cold weather procedures. In California and Florida people are sailing, swimming, hang gliding, and sun bathing. Perhaps the only hints of winter are the shorter days, winter colors in the clothing stores, maybe a tree down the block that is shedding its leaves only so that it can sprout some new ones, and pilots and aircrew going over cold weather procedures.

Why should pilots and aircrew from P-3 squadrons based in such beautiful climates even concern themselves with snow, ice, and frost? Well, the P-3 is not a carrier-based aircraft that launches, then returns exactly 1.5 hours later. Rather, it is a long-range patrol aircraft that can tuck its wheels up and bring them down twelve hours later in another part of the world – the P-3's "other part of the world" being Adak, Misawa, Brunswick, Keflavik, etc. Even a flight from California to Jacksonville, Florida crosses some pretty rugged terrain that may be laced with weather as rugged as the Sawtooth Mountains of Idaho.

PERSONAL GEAR

To prepare yourself for a flight to a location where the climate is cold, you will have to stretch your imagination . . .

Imagine bailing out over the Rocky Mountains in the middle of winter. After you make a nice soft

Official U.S. Navy Photo

landing into a snowbank, you release your parachute harness and brush the snow off your flight suit. The wind is blowing hard from the north, down from Canada. The rest of the crew is scattered throughout the canyons and ridges. You really feel alone and chilled.

Or imagine getting up at 0430 for an 0530 preflight at NAS Brunswick, Maine. You are walking to the flight line, and although the stars are bright, a bitter cold wind is blowing dry snow off the frozen ground right into your face and down your neck.

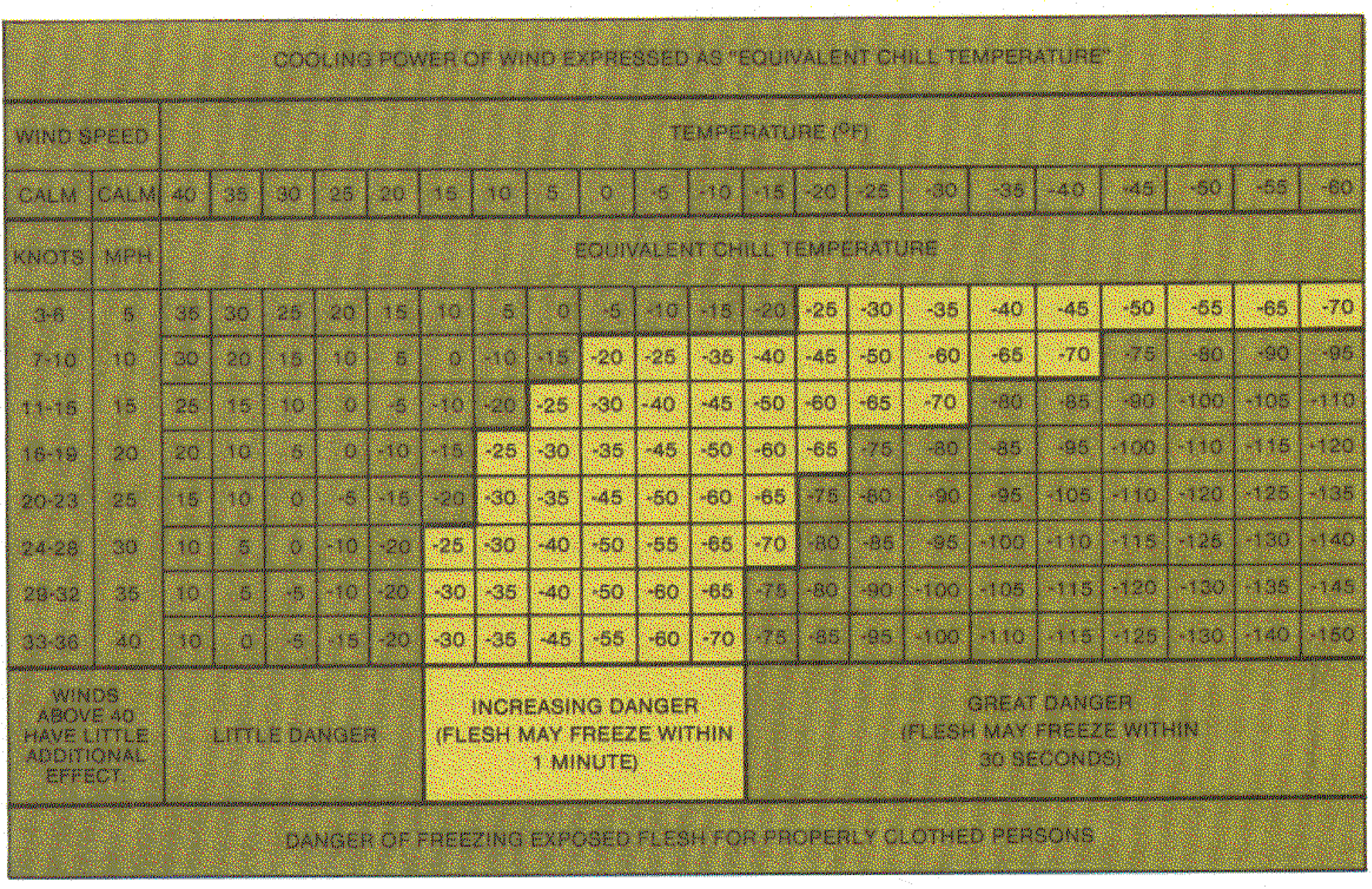
In either case, probably the most important items of personal gear are a pair of "long johns" and warm clothes. Aircrews have held the general opinion that long johns are too bulky and restrictive, but this is no longer the case. Almost every sporting goods store carries products whose material is very lightweight and thin, yet the garments are warm and stylish. Even turtlenecks are available that would be quite practical to wear under a flight suit.

It certainly takes forethought and reasoning to want to wear warm underclothing when you are preflighting your aircraft in 70°F weather. Inflight, however, the cabin air temperature can be kept lower to prepare the crew for arrival at a cold destination. Foul weather flight suits should be checked out from the aviator's equipment shop. These well-insulated suits can be carried on board the aircraft and slipped over regular flight suits before exiting the aircraft into cold weather. And don't forget your civilian coat. There is nothing colder than a standard-issue leather flight jacket. Figure 1 is an equivalent chill temperature chart that is used in computing equivalent chill factors.

PREFLIGHT

Probably the time that an aircraft needs the most attention is when you least want to give it, during preflight. The aircraft has been sitting out in the cold all night, the seals are cracking, the oleos are bleeding, snow and ice are frozen on its top surfaces, and the tires are frozen to the ramp. The low temperature has lowered your efficiency, and all that you want to do is to forget the preflight and get into the nice warm cabin and fly to the avocado groves of sunny California. *Don't do it!*

More than ever, the aircraft needs a thorough preflight inspection and a check of all anti-icing and de-icing systems. Refer to the aircraft's daily maintenance requirements cards and to the turnaround checklist. The preflight inspection should include the following:



COOLING POWER OF WIND EXPRESSED AS "EQUIVALENT CHILL TEMPERATURE"

WIND SPEED		TEMPERATURE (°F)																				
CALM	CALM	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50	-55	-60
KNOTS	MPH	EQUIVALENT CHILL TEMPERATURE																				
3-6	5	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50	-55	-65	-70
7-10	10	30	20	15	10	5	0	-10	-15	-20	-25	-35	-40	-45	-50	-60	-65	-70	-75	-80	-90	-95
11-15	15	25	15	10	0	-5	-10	-20	-25	-30	-40	-45	-50	-60	-65	-70	-80	-85	-90	-100	-105	-110
16-19	20	20	10	5	0	-10	-15	-25	-30	-35	-45	-50	-60	-65	-75	-80	-85	-95	-100	-110	-115	-120
20-23	25	15	10	0	-5	-15	-20	-30	-35	-45	-50	-60	-65	-75	-80	-90	-95	-105	-110	-120	-125	-135
24-28	30	10	5	0	-10	-20	-25	-30	-40	-50	-55	-65	-70	-80	-85	-95	-100	-110	-115	-125	-130	-140
29-32	35	10	5	-5	-10	-20	-30	-35	-40	-50	-60	-65	-75	-80	-90	-100	-105	-115	-120	-130	-135	-145
33-36	40	10	0	-5	-15	-20	-30	-35	-45	-55	-60	-70	-75	-85	-95	-100	-110	-115	-125	-130	-140	-150
WINDS ABOVE 40 HAVE LITTLE ADDITIONAL EFFECT		LITTLE DANGER					INCREASING DANGER (FLESH MAY FREEZE WITHIN 1 MINUTE)							GREAT DANGER (FLESH MAY FREEZE WITHIN 30 SECONDS)								
DANGER OF FREEZING EXPOSED FLESH FOR PROPERLY CLOTHED PERSONS																						

Figure 1. Equivalent Chill Temperature Chart

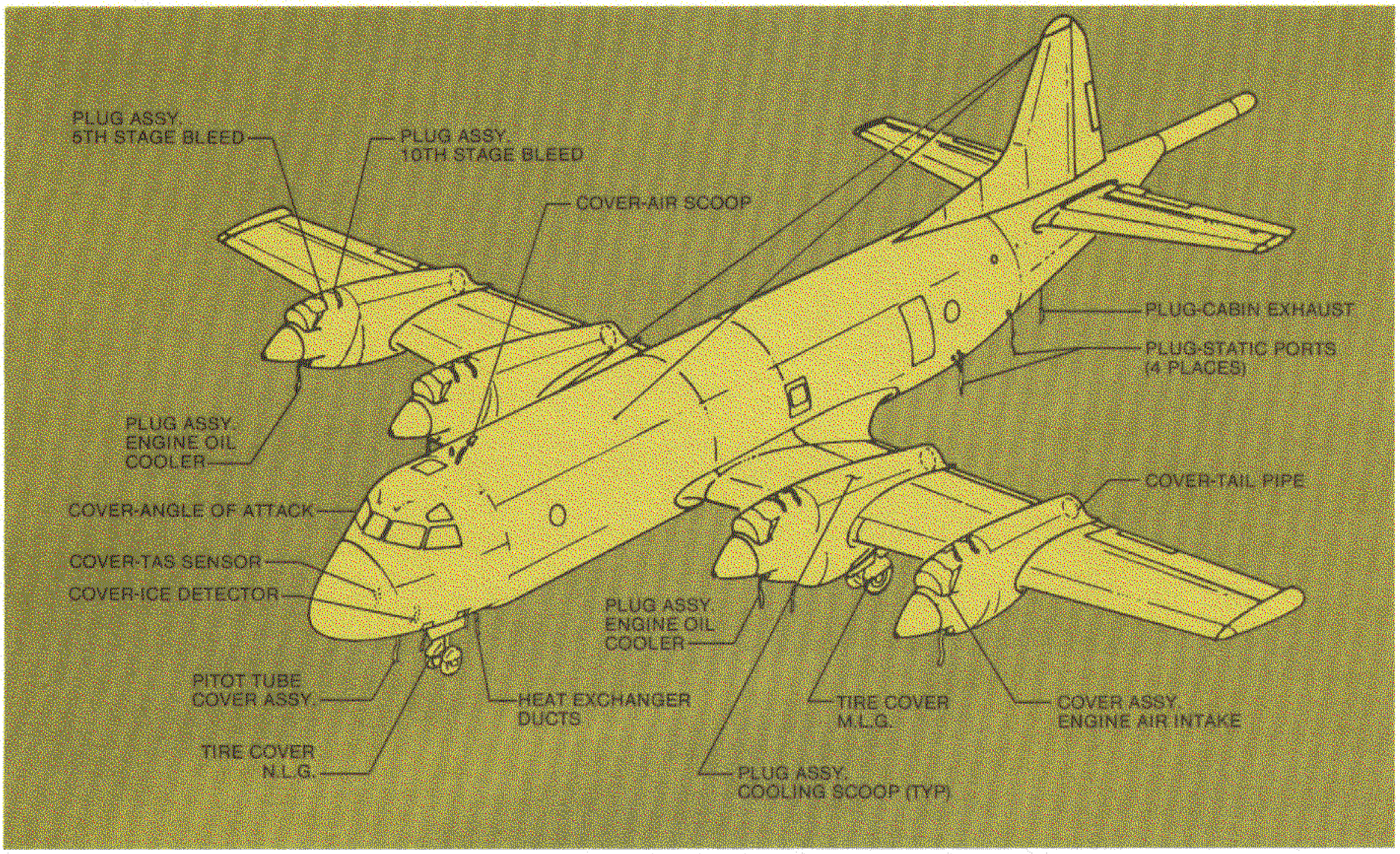


Figure 2. Service Cover Locations on P-3 Aircraft

- Check the landing gear and wheel wells to ensure that they are clear of snow, ice, or frozen mud. Such accumulations can cause damage to limit switches and locks.

- Ensure that the wheel chocks and tires are not frozen to the deck. Snow chocks or sand bags provide an excellent means to safety chock aircraft landing gear under cold weather conditions and are less likely to slide than are regular chocks.

- Tires frozen to the ground may be freed by the following methods:

  a. Overinflation – Tire pressure may be raised up to 50 percent above normal to free the tire from a frozen surface. Overinflated tires must have their pressures returned to normal before the aircraft is taxied.

  b. Ground Heat Application – Apply hot air to the tires and the frozen surface. However, apply ground heat with caution because it can raise tire pressure beyond safe limits.

  c. Apply de-icing fluid.

- Check the landing gear shock struts for proper pressure and extension. Low struts can be induced by low temperatures, but a flat strut may be evidence of hydraulic leaks. Warm the strut before servicing it.

- Check the hydraulic systems for leaks. Minor hydraulic leaks may be common after an aircraft has been exposed to low temperatures for prolonged periods, and they are usually difficult to eliminate without replacement of lines and fittings. After the hydraulic systems have been pressurized and the subsystems operated (where possible), recheck the minor leaks and determine whether the hydraulic systems are serviceable.

- Ensure that the ice detector probe, static ports, pitot tubes, and exterior drains are free of accumulations of ice and snow (Figure 2).

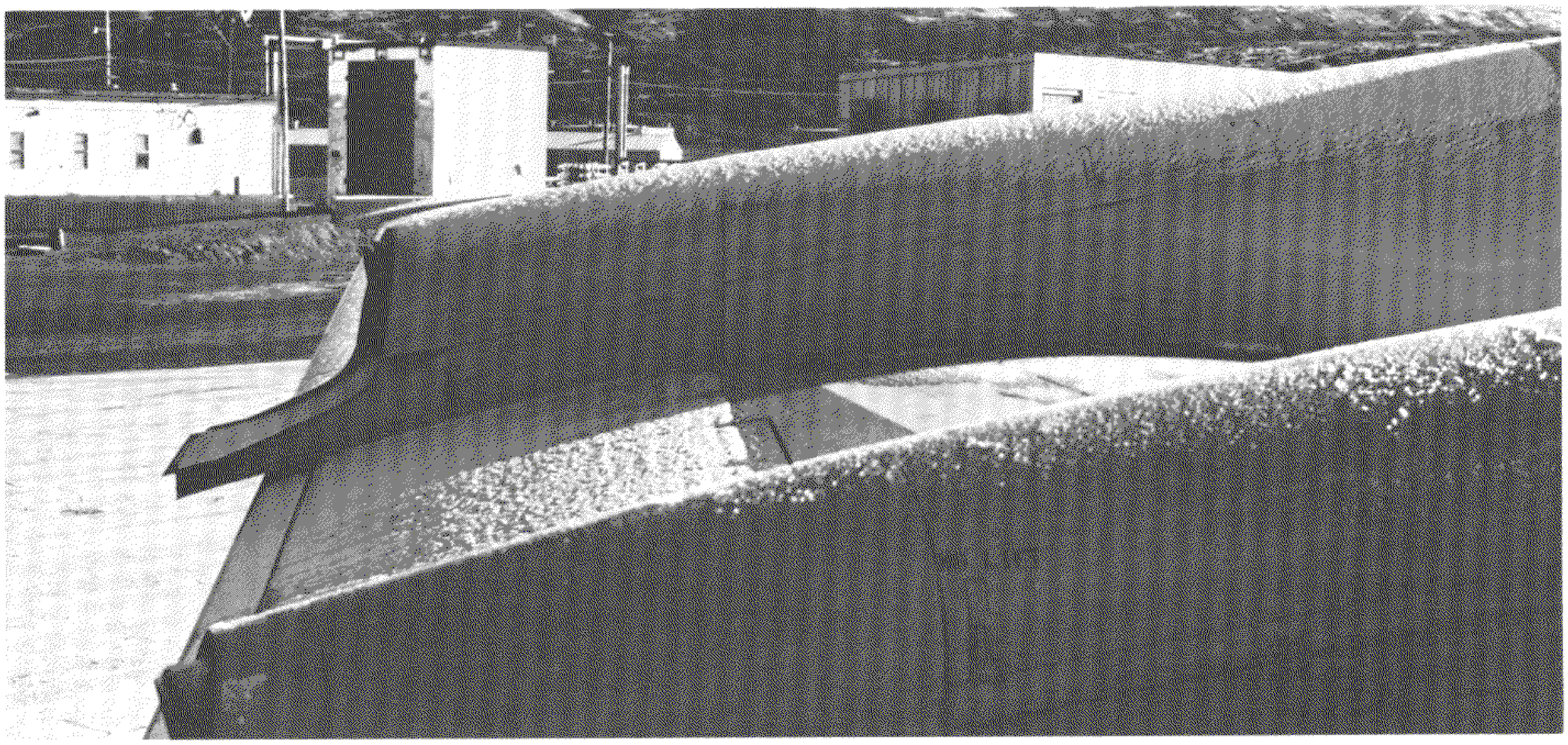


Figure 3. Frost Accumulation on Wing of a CP-140 Aircraft *Photo by Jim Upton*

- Ensure that the engine air intakes are free of ice and snow. Any accumulations must be removed. The surest method is by placing the aircraft in a heated hangar and letting the ice and snow melt.

- Frost, snow, and ice must be removed from all aircraft surfaces, not just the wings and empennage. Ice and snow accumulations on the fuselage affect the airplane's aerodynamics and are added weight. These accumulations can also be a safety hazard to personnel on the ground. On the takeoff roll, snow on the radome will blow onto the windshield and can obscure forward vision.

A P-3 crew once felt that the snow and ice on top of their aircraft's fuselage would not seriously degrade its takeoff and climb performance. They were right. The P-3 lifted off and climbed by the numbers. The only problem was that they dumped the load of ice onto a busy freeway.

Frost aids in ice formation, acting as a nucleus for the initial buildup. This, in turn, disturbs the smooth airflow over the airfoil surfaces, enhancing drag and increasing fuel consumption. The P-3 has plenty of power to overcome the additional drag, but many small aircraft would never get off the ground with frost on the wings. An example of frost accumulated on a CP-140 wing is shown in Figure 3.

Ice, though, is the biggest culprit. If ice is present – and especially if rain has become frozen overnight – check the *entire* aircraft for the presence of ice, and remove *all* ice from control surfaces, hinges, flaps, stabilizers, wings, wing fillets, engine inlets, propellers, and wheel well door areas.

WARNING

Each person working on ice or snow-covered surfaces *must* wear a safety harness. Snow and ice conditions make walking on wings, stands, and entrance ladders hazardous. Snow often hides ice patches, and surfaces coated with deicing fluid can also be very slippery.

WARNING

The airplane's wing and empennage deicing systems shall *not* be used for ice and snow removal while the aircraft is on the ground. These systems apply heat to the airfoil leading edge only. If these systems are used to melt ice and snow, the water runoff may accumulate elsewhere and refreeze, perhaps in a more critical area. Also, extended ground operation of wing and empennage deicing systems can produce temperatures that are high enough to reduce the strength of the leading edge skins.

CAUTION

Do not spray deicing fluid into static ports or engine inlets. Deicing fluid can cause corrosive damage to these surfaces. Do not spray deicing fluid on the aircraft when the APU is operating.

Ice and snow can be removed rapidly and efficiently from the aircraft if deicing fluid is applied to its surfaces before the ice or snow accumulates. The snow can then be removed by brushing the surfaces with a stiff broom. Application of heated deicing fluid to ice or snow accumulations will also facilitate removal.

CAUTION

Ice and snow shall be removed mechanically only by *brushing* the surface. Hammering or chipping is prohibited.

- Pull the propellers through slowly and check them to ensure that the blades, cuffs, and islands are free of ice and snow. Severe engine vibrations will occur on start if the blades are not cleaned thoroughly. When cleaning the propeller blades, take care not to scratch them. During start, ground personnel should stand well clear of the plane of propeller rotation to avoid being hit by flying ice.

- Inspect fuel drains and fuel filter housings for ice accumulations. The presence of ice in drains or on filter housings may indicate that ice has formed in the fuel sumps or tanks. If ice has formed, warm the aircraft in the hangar until the ice has melted. Ensure that all fuel vents are clear of ice and snow.

- Inspect the propellers for hydraulic leaks. External hydraulic leakage may occur if the propellers are cycled statically or dynamically at low ambient temperatures (below 0°C) because the blade seals have taken a "cold set." Avoid unnecessary static and dynamic cycling of the propeller blades until the engine oil temperature is above 0°C.

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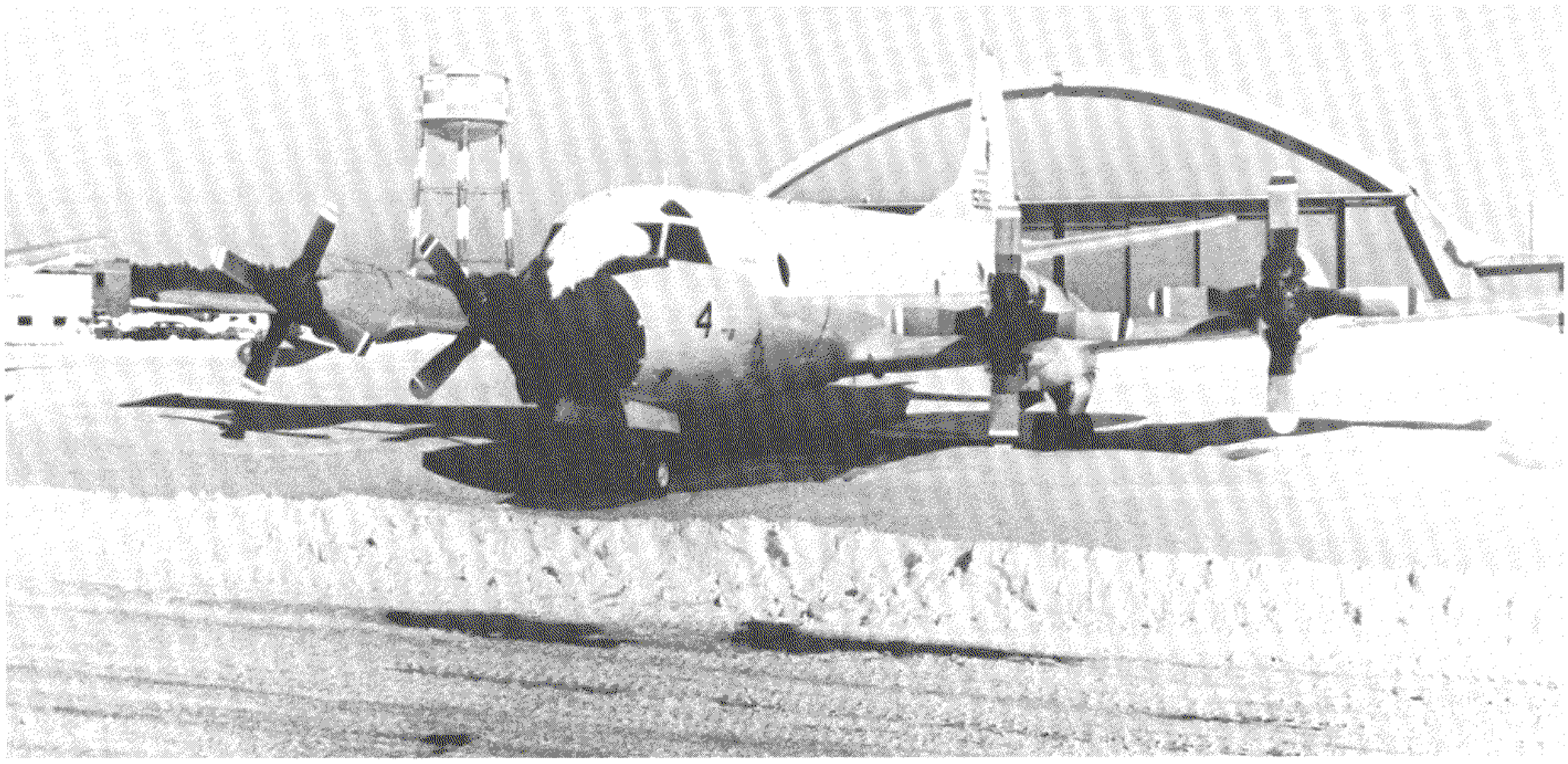
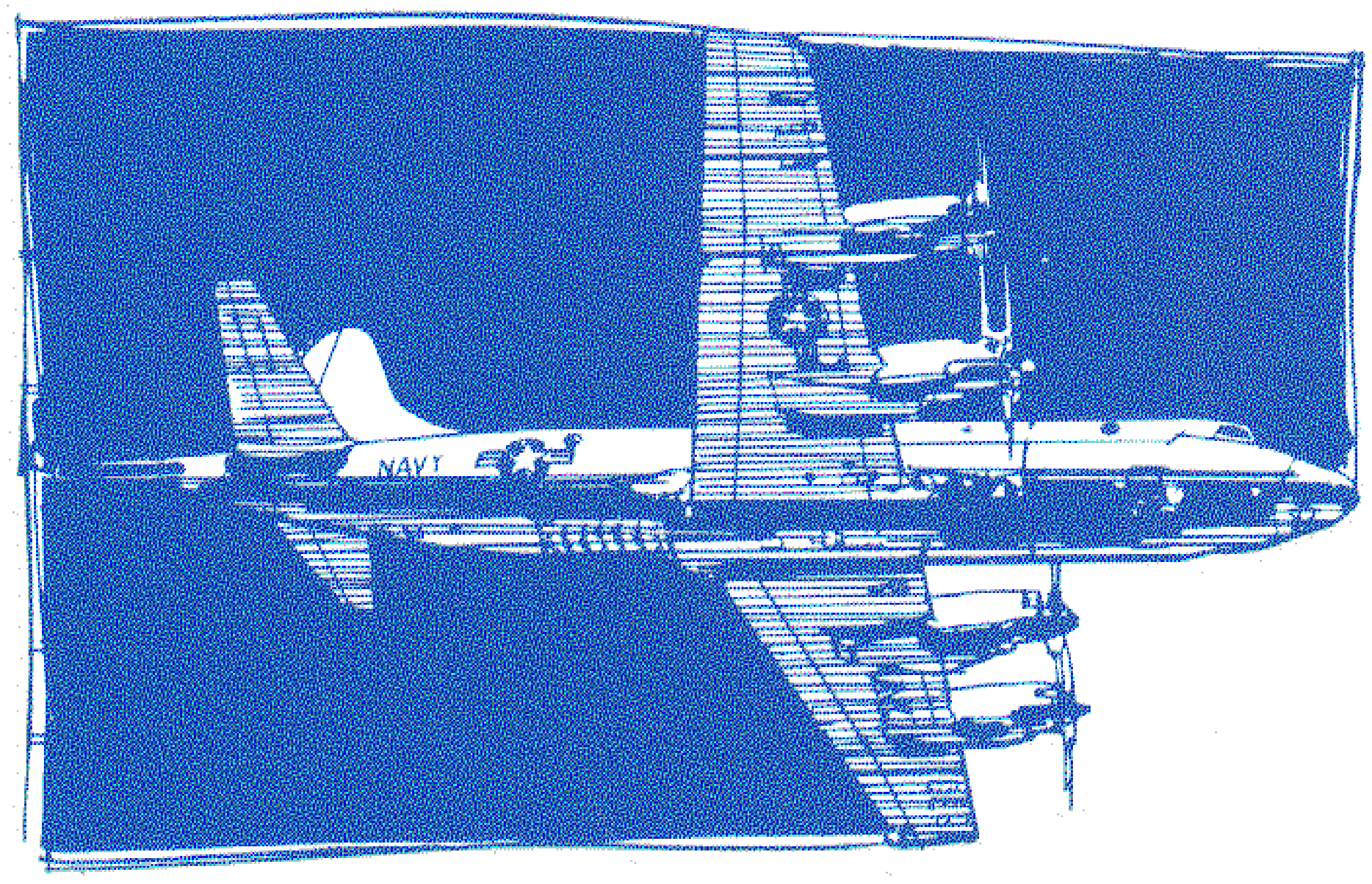


- Windshield heat should be applied, but with caution, especially if the airplane has been allowed to "cold soak" for a long period. During very cold conditions (-40°C or below), preheat the windshield with warm air heaters before selecting the windshield heat to LOW. This prevents the windshield panels from cracking due to thermal shock. Operating the ground air conditioning at high temperature will also help to preheat the windshield panels. If it is impractical to preheat the panels with directed warm air, they may be warmed slowly by manually cycling the windshield heat control switch between OFF and LOW. When this method is used, apply heat to the panel for a few seconds at a time with pauses of about one minute between heat applications until the panel no longer feels cool to the touch. The OVERRIDE switch must also be activated when the panel temperature is below approximately -35°C.
- Lower the flaps and check for ice accumulations in the flap wells and on the flap asymmetry mechanisms.
- Actuate the flight controls to eliminate cold hydraulic fluid in the booster packages.
- Allow sufficient time for the ASN-42 Inertial Navigation System's environment to warm to its normal operating temperature of 160°F (71°C) before caging the system.* The INS heater will raise the system's environmental temperature at a rate of about 10°F (6°C) per minute.



Don't get rushed. Allow yourself about twice as much time as is normally anticipated. A good preflight is a necessity in foul weather.

START

Starting engines in cold weather poses no unusual problems. Normal starting procedures can be used if attention is paid to engine limitations. The engines or the APU may be started with the oil temperature down to a minimum of -40°C with MIL-L-23699 oil, and down to -54°C with MIL-L-7808 oil. If the oil temperature is lower than permissible, preheat should be applied until the oil is warmed to the minimum operating temperature. When an airplane is deployed to a site where preheat is not available and the cold start oil temperature is expected to be below -40°C, MIL-L-23699, oil should be drained and the engines reserviced with MIL-L-7808 oil before deployment.

After engine start, leave the power levers in the START position until the engine oil temperature reaches 0°C. With the oil temperature between 0°C and 40°C, the power levers may be set to 1000 SHP to expedite warm-up. When the oil temperature reaches 40°C and the gear box oil pressure indication shows no fluctuation, maximum power may be applied.

In extremely low temperatures, hydraulic fluid may leak from the propeller blade seals during engine start. This leakage should cease when normal operating oil temperature has been reached. If such leakage is observed, operate the engine until the gear box oil temperature reaches 40°C then shut down the engine. Check the propeller oil quantity and replenish the oil, if necessary. Restart the engine and check the propeller blade seals for further oil leakage.

TAXI

Taxiing on packed snow, slush, or ice is extremely exciting (read: hazardous), particularly when you

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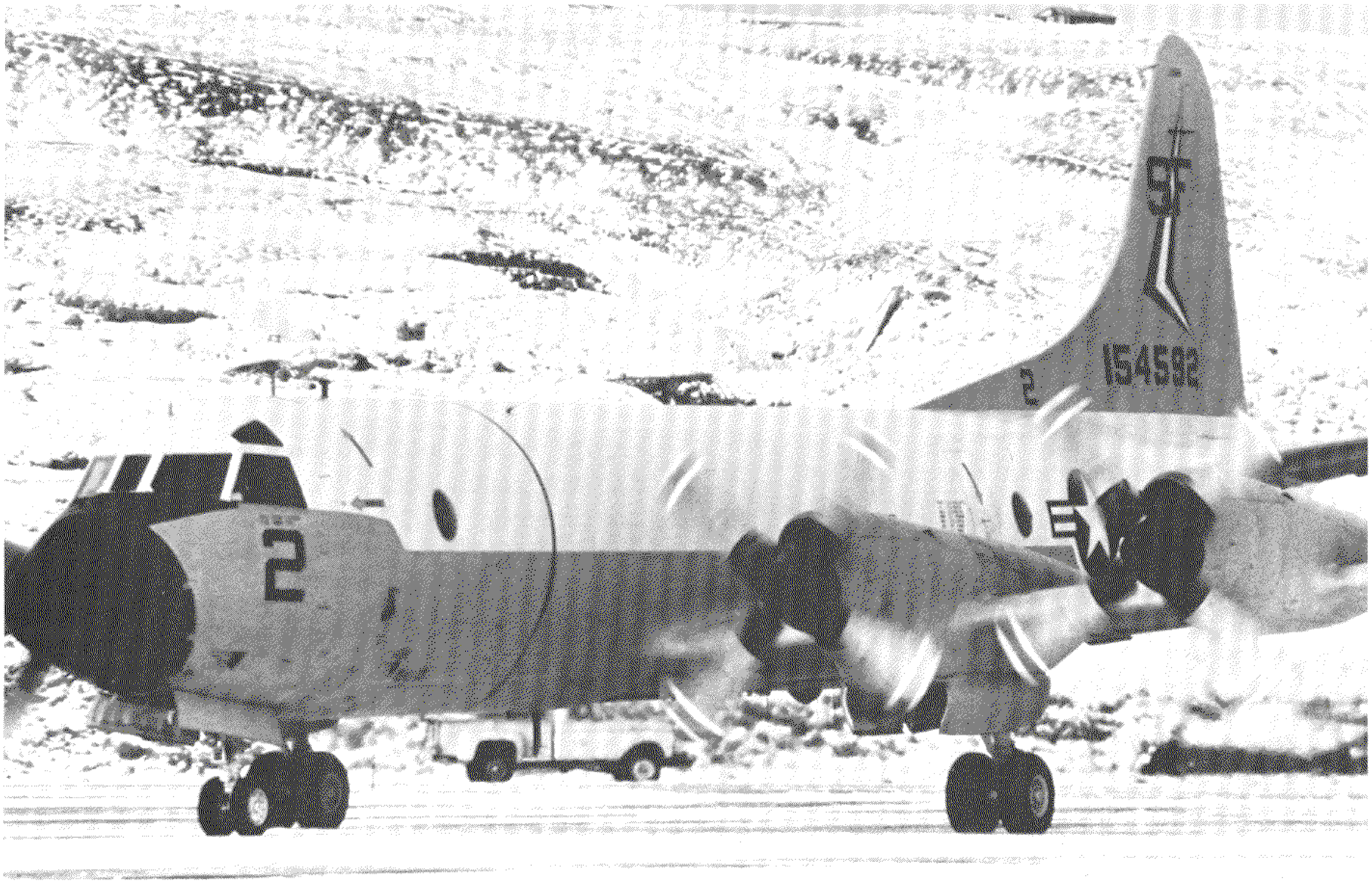
* *P-3A and P-3B aircraft only*



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are in the vicinity of other multi-million dollar aircraft, vehicles or snowbanks, and especially so when you have a crosswind or tailwind component. The best general rule is to taxi very slowly, making wide rolling turns. Here are some helpful guidelines and precautions:

- Find the best route to the runway. Use the widest taxiways available.
- Bring your crew forward to the flight station and radio compartment during taxi. This will place additional weight on the nose wheel.
- Shut down the APU and check that its air intake and exhaust doors are closed before commencing taxi. This precaution is taken to prevent ice chunks from being drawn into the APU air intake during taxi.
- Taxi with the flaps up.
- At the start of taxi, visually confirm that the main landing gear wheels are rolling.
- With either LOW or NORMAL rpm on symmetrical engines, use *asymmetrical* thrust to maintain directional control during taxi. The power changes should be smooth, since the tendency is to overcontrol.
- Have the copilot hold aileron into the wind. With a strong tailwind, hold the yoke full aft. This will decrease downward lift on the horizontal stabilizer, which will increase weight on the nose wheel.
- Nosewheel steering is ineffective on ice and snow. The nose wheel can be turned in a direction that is quite different than the direction of aircraft movement. This condition will become readily apparent if you hit a dry spot. If the nose wheel is cocked in

the wrong direction during taxi, slow the aircraft to a complete stop, straighten the nose wheel, then resume taxi. The pilot may rest his hand on the nose wheel steering control to determine the rate and direction of nose wheel movement. However, do not use this as a primary control to steer the aircraft on ice or snow.

- Watch ground clearance, especially near snowbanks. The outboard propellers clear the ground by slightly more than 30 inches with normal strut extension. On P-3A and P-3B aircraft, the searchlight is five feet from the ground and is outboard of the number four engine spinner by about ten feet. When taxiing close to snowbanks, shut down the outboard engines and position the propellers to get the most clearance. If a propeller contacts a snowbank or other obstruction, shut down the engine *immediately* with the FUEL AND IGNITION switch and perform a detailed inspection of the aircraft prior to engine restart.

WARNING

> Do not use the engine E-handle or feather button to shut down a power plant whose propeller has contacted a snowbank or other obstruction. Any subsequent propeller contact of the obstruction at high blade angles may cause propeller failure.

- Check the brakes while moving the aircraft out of the chocks. At near-freezing temperatures, the brakes will be completely ineffective on ice. In these conditions, only reverse thrust and application of differential power can be used to slow and turn the aircraft. The brakes are generally more effective on snow or slush and on ice at colder temperatures.
- Use of excessive reverse thrust will blow loose snow ahead of the aircraft and can obscure the vision of the flight crew. The slush and ice thrown forward also can damage the propellers and engines.

PRE-TAKEOFF

Before flying into anticipated icing conditions, perform a complete check of all aircraft deicing and anti-icing systems as described in the NATOPS Flight Manual. Check the propeller and empennage ice control systems by using the test positions of the systems' respective control switches; the system test switch positions bypass the circuitry to the ground air sensing relays and allow the systems to be checked on the ground. Also check the windshield heat systems to ensure that they are operating properly.

Check the wing deicing system, and monitor each wing section for proper deicing system operation.

CAUTION

> Full operation of the wing deicing system on the ground is prohibited. Such system operation may cause overheating, which in turn may cause structural damage to the wing leading edges. Such operation may also produce water runoff from ice meltdown that can accumulate elsewhere in the wing leading edge area and refreeze.

The engine anti-ice systems should not be used during taxi and takeoff unless icing conditions exist at or near ground level. Icing is likely to occur at or near ground level when there is high atmospheric moisture content and the ambient temperature is 8°C or lower.

TAKEOFF

During cold weather operations, all factors that affect takeoff performance must be carefully considered prior to takeoff roll. Some of these factors are aircraft weight, runway length and surface condition, obstacle clearance, air density altitude, and wind. When all other factors are considered, it may be desirable to take off with a crosswind or tailwind component. However, keep in mind that the maximum crosswind component for takeoff should be 10 knots on ice and 20 knots on snow.

Prior to every takeoff compute the $V_{MC\ GRD}$* and decision/refusal speed as accurately as possible, based upon the current runway conditions. The distance required to accelerate and stop on an ice-covered runway may be twice that required on a dry runway. Other factors to consider when computing takeoff performance include:

- Three-engine stopping performance – Since nosewheel steering is ineffective on ice and snow, asymmetric thrust is used for directional control. Under these conditions, the total usable deceleration thrust available is not the maximum for three engines. In balancing the reverse thrust with a feathered outboard propeller, the total deceleration thrust will be approximately equal to that of two engines. With an inboard engine feathered, the reverse thrust available will be slightly higher.
- Lack of nosewheel steering.
- Time lost in transitioning from takeoff power to reverse thrust – The transition time is greater on ice or snow than on a dry runway because of the effect of power change on directional control.
- Propeller reverse thrust versus true airspeed.
- Directional control using asymmetrical power.

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* *Minimum control speed on ground.*

Official U.S. Navy Photo

Photo by Jim Upton

- The effects of hydroplaning on wet runways – Dynamic, viscous, and rubber reversion hydroplaning may occur on wet runways.

  a. *Dynamic* – This type of hydroplaning occurs when the runway is flooded. Fluid pressures develop between the tire footprint and the pavement, and completely lift the tire off the pavement. Dynamic hydroplaning occurs at speeds in excess of nine times the square root of the tire pressure. Example: With tires inflated to 160 psi, dynamic hydroplaning occurs at speeds above 115 knots (approx.) and continues until the speed falls below 7.2 times the square root of the tire pressure.

  b. *Viscous* – This type of hydroplaning occurs only on very smooth or "slick" runway surfaces when they are damp or covered with a thin layer of fluid. Again, the fluid is interposed between the tire footprint and the runway surface, and lifts the tire off the pavement. Viscous hydroplaning can occur at much lower ground speeds than dynamic hydroplaning.

  c. *Rubber Reversion* – This type of hydroplaning occurs when a wheel brake locks, followed by a skid. The subsequent friction between the tire and the runway surface melts some of the tire tread, producing heat. The heat, in turn, converts ice or water on the runway into steam, a cushion of which forms between the tire footprint and the runway surface. Rubber reversion hydroplaning can occur at speeds as low as 5 knots.

Hydroplaning in any form results in the loss of braking action, and there is the potential for loss of ground directional control. To prevent hydroplaning during an aborted takeoff, use reverse thrust to slow the aircraft below the hydroplaning range before brakes are applied.

Under most conditions, decision speed will be equal to $V_{MC\ GRD}$ or approximately 100 knots. On ice-covered runways, $V_{MC\ GRD}$ may be increased to $V_{MC\ AIR}$* or approximately 110 knots. In this latter situation, once decision speed is reached refusal may be impossible. Snow or slush-covered runways provide better braking and stopping conditions than ice-covered runways, but the takeoff distances are increased accordingly. Table 1 shows as a percentage the increased takeoff roll required for a P-3 airplane to reach liftoff speed from a snow or slush-covered runway versus a runway that is dry.

If icing conditions prevail on the ground or will be encountered shortly after takeoff, turn the engine anti-icing system *on* before takeoff. On the other hand, the wing deicing system should be left *off* during takeoff since the engine power loss incurred is excessive when compared to the value gained from reduced drag. The propeller deice and empennage ice control systems should be turned *on* as soon as practical after takeoff. Set windshield heat from LOW to HIGH before takeoff, as shown in the "Takeoff" section of the P-3 NATOPS Flight Manual Normal Checklist.

CAUTION

> If ice is allowed to build up on the windshield prior to selecting HIGH power, thermal shock may damage the windshield panels. Use a warm-up period of at least 10 minutes at LOW power before selecting HIGH power.

Before commencing takeoff from a slush-covered runway, line up the aircraft with the center of the runway to provide ample maneuvering room. And, as ridiculous as this may seem, ensure that you have released the parking brakes before commencing the takeoff roll. If there is any chance of the airplane contacting a snowbank during takeoff, vacate the crew stations near the propeller plane to help protect crew members from being struck by propeller fragments.

Make rolling takeoffs on ice and snow, using differential power for directional control until the rudder becomes effective. When the rudder becomes effective, the flight engineer should maintain the power setting. On rough runways, maintain zero elevator angle (yoke even with the aft edge of the glareshield) to reduce loads on the nose landing gear strut. During takeoff, increased stick forces will be required to break the nose wheel free of the slush. After takeoff, delay retracting the landing gear for a few seconds to allow the slush to blow off, then cycle the landing gear and flaps to prevent any remaining slush from accumulating and freezing them in the "up" position. Watch your horsepower limitations during takeoff. In cold temperatures it is relatively easy to "overboost" an engine.

Crosswind takeoffs on ice and snow are extremely hazardous and should be conducted with extreme caution. Hold aileron into the wind and maintain directional control with differential power. When rudder control is established, call for maximum allowable power. Use normal crosswind techniques for liftoff.

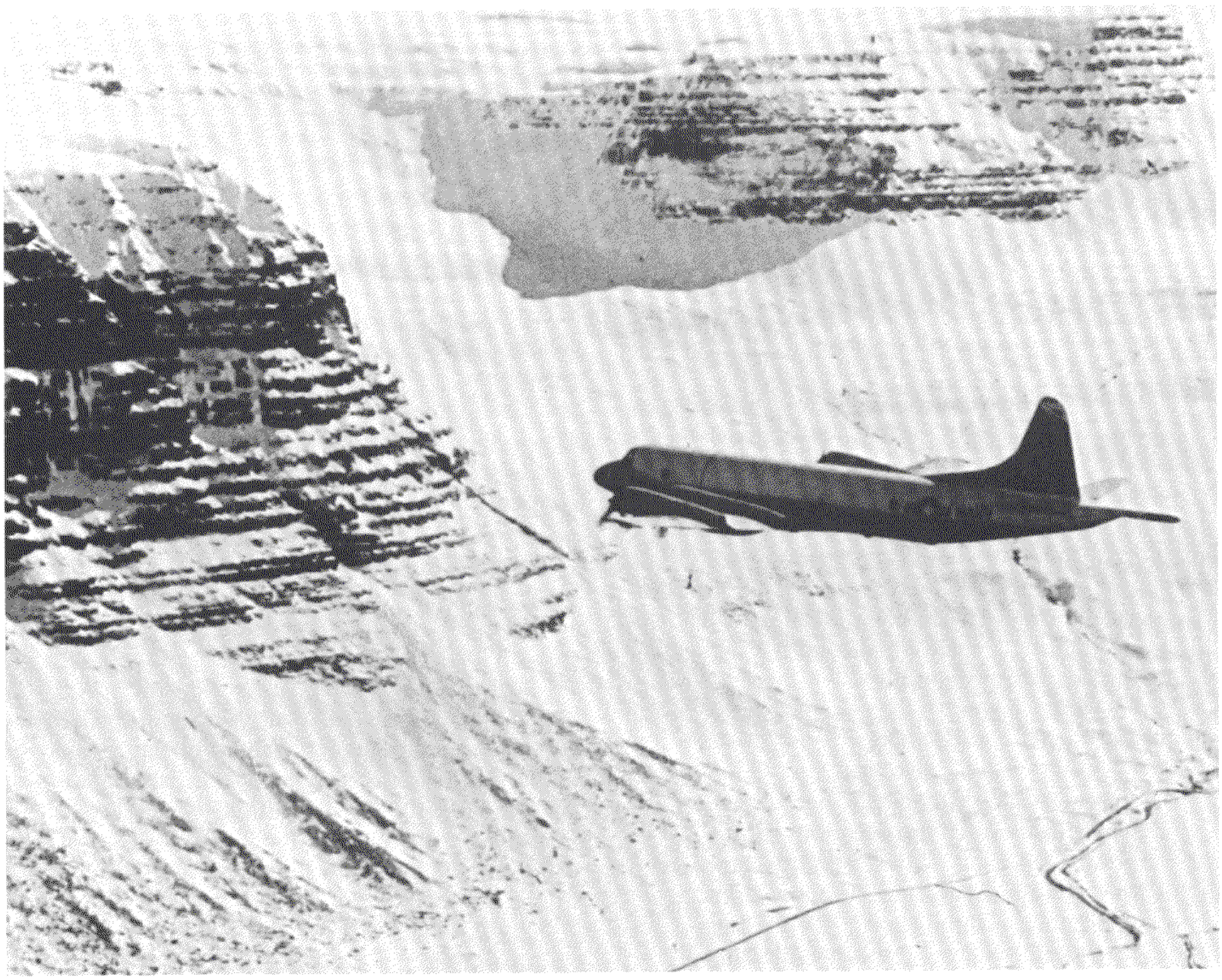
As soon as possible after takeoff in icing conditions, check the wing leading edges for ice buildup so that timely deicing procedures may be employed. During daylight the wings may be observed from the flight station. At night it may be necessary to use an Aldis lamp from the forward cabin crew stations to illuminate the wing leading

TABLE 1

WET (DENSE) SLUSH OR WATER DEPTH	DRY SNOW DEPTH	APPROXIMATE INCREASE IN TAKEOFF DISTANCE
1/4 inch	3 inches	6 percent
1/2 inch	4 inches	15 percent
3/4 inch	5 inches	28 percent
1 inch	Not Recommended	50 percent

Note:
During takeoff, treat everything as wet (dense) slush or water except dry snow. When the runway has more than 3/4-inch of slush or standing water, or has snow in excess of 5 inches, takeoff is not recommended.

Minimum control speed in air.



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edges for visual inspection. Select propeller and empennage deice to *on* as soon as practical after takeoff. For those aircraft equipped with EDC inlet heat, this is the time that it should be turned on.

FLIGHT

Careful planning is a "must" before departing into known or suspected icing conditions. Briefing yourself with closed circuit weather video is adequate under most circumstances, but it is not always possible to get the total weather picture and retain it in your mind in this manner. A forecast is an educated prediction – pressure patterns and other factors change. Knowing how these factors affect a forecast enhances your safety of flight in icing conditions.

The freezing level is a good point to keep in mind. During the winter months, the freezing level is frequently on the deck. Cloud levels along your route, in conjunction with the freezing levels, are important considerations that can help one accurately predict icing areas. The following paragraphs present some useful facts about icing in general, and also discuss clear and rime ice.

ICING Expect icing conditions in any form of cloud where the air temperature is less than +2°C. Icing is not a great hazard during flight above clouds, and it is no hazard during flight in ice clouds or dry snow and sleet conditions unless the sleet is mixed with supercooled water. These forms of ice do not ordinarily adhere to aircraft structure. Icing is severe in frontal zones and in upslope conditions over mountains and weather fronts.

Clear ice, also called glaze ice, is a dense and solid deposit that adheres firmly to aircraft structure. It is the most dangerous form of ice. Clear ice is most likely to form when the ambient air temperature is between +2°C and -10°C. Expect clear ice to form during flight in clouds whose air temperature is within this range, where vertical air currents can support large water droplets. These conditions may occur when any of the following types of atmospheric activity is present:

- Convective action from surface heating.
- Vertical convection force by cold fronts.
- Active upglide of warm air over warm fronts.
- Upslope lifting.
- Those conditions associated with unstable air.

Figure 4 shows a typical example of clear ice buildup on an airfoil.

Rime ice is a granular, whitish, opaque, rough deposit, and is a greater drag inducer than clear ice. Generally, it adheres only to aircraft leading edges. Rime ice is most prevalent at temperatures between +2°C and -10°C. It may occur at temperatures below -10°C in cumulus-type (cumuloform) clouds. Rime ice can be expected during flight in stratus-type (stratiform) clouds where vertical air currents are of sufficient strength to support large water droplets. Stable air conditions usually prevail in areas of rime ice formation. Figure 5 shows an example of rime ice buildup on an airfoil.

FLIGHT OPERATIONS The P-3 can maintain altitude with a considerable load of ice. However, safety and economics dictate that flight with continuous icing should be avoided. Climb or descend when you encounter icing in stratiform clouds. Climbing may be the first consideration, since icing usually does not occur above 20,000 feet except when vertical air currents are encountered in areas over mountains or near thunderstorms. Change your heading in areas where you encounter cumuloform clouds and when you note that ice is beginning to accumulate on the aircraft. Attempt to transit weather fronts perpendicularly.

Avoid steep turns and climb angles if ice has accumulated on the aircraft to any degree. When flying in icing conditions, it is a good idea to disengage the aircraft's autopilot to fly manually every so often in order to cycle the trim tabs to prevent them from freezing. Remember, ice can accumulate on the underside of the wing and tail when the aircraft is maneuvered at low speeds or at high angles-of-attack, resulting in some loss of stability.

When operational requirements permit, maintain a minimum airspeed of 200 knots, gear and flaps up, during flight in icing conditions. Extension of flaps or landing gear while in an icing environment will result in ice buildup on their leading edges, in the wing rear spar area, and in the wheel wells. Retraction of flaps or landing gears when ice deposits are present in these areas could cause damage to flap components or to the wheel well structure. If flap extension in excess of MANEUVER is required in an icing environment, do not subsequently retract the flaps any further than the 20 percent position.

During flight, engine anti-icing heat should be turned on before you enter any locality where

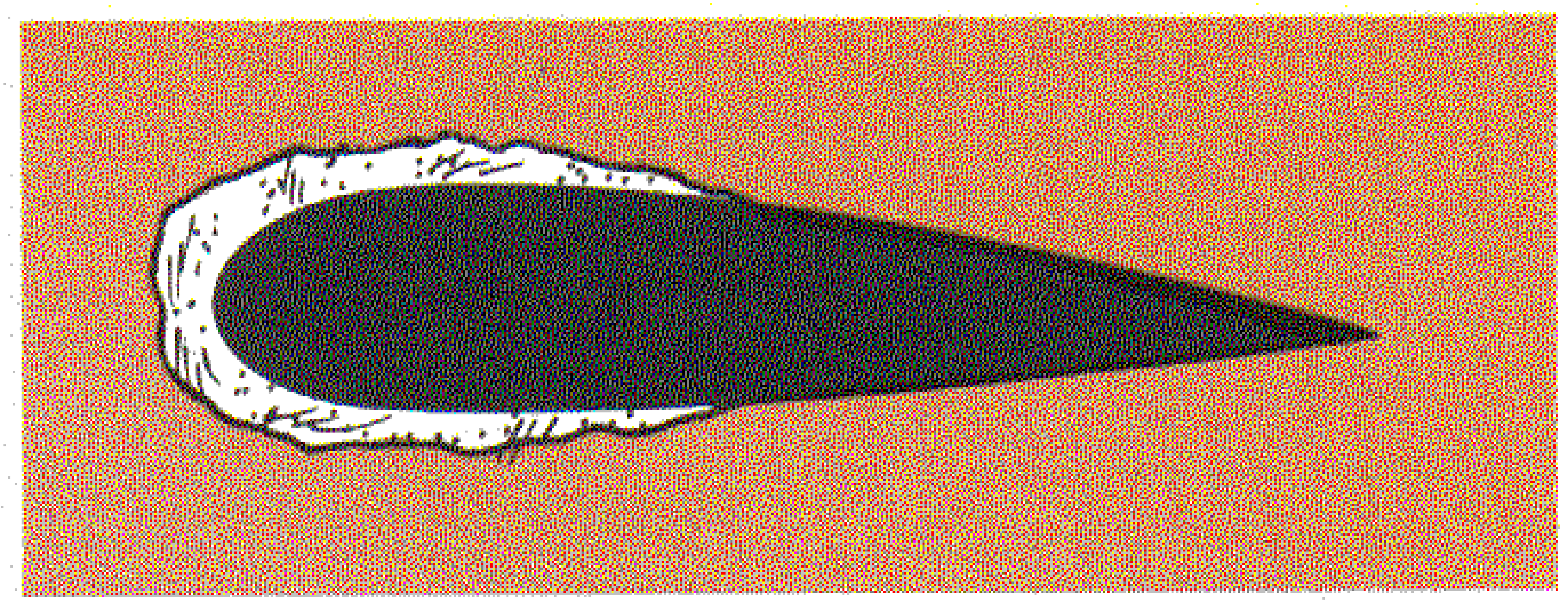

Figure 4. Clear Ice on Airfoil – Hard and Glossy

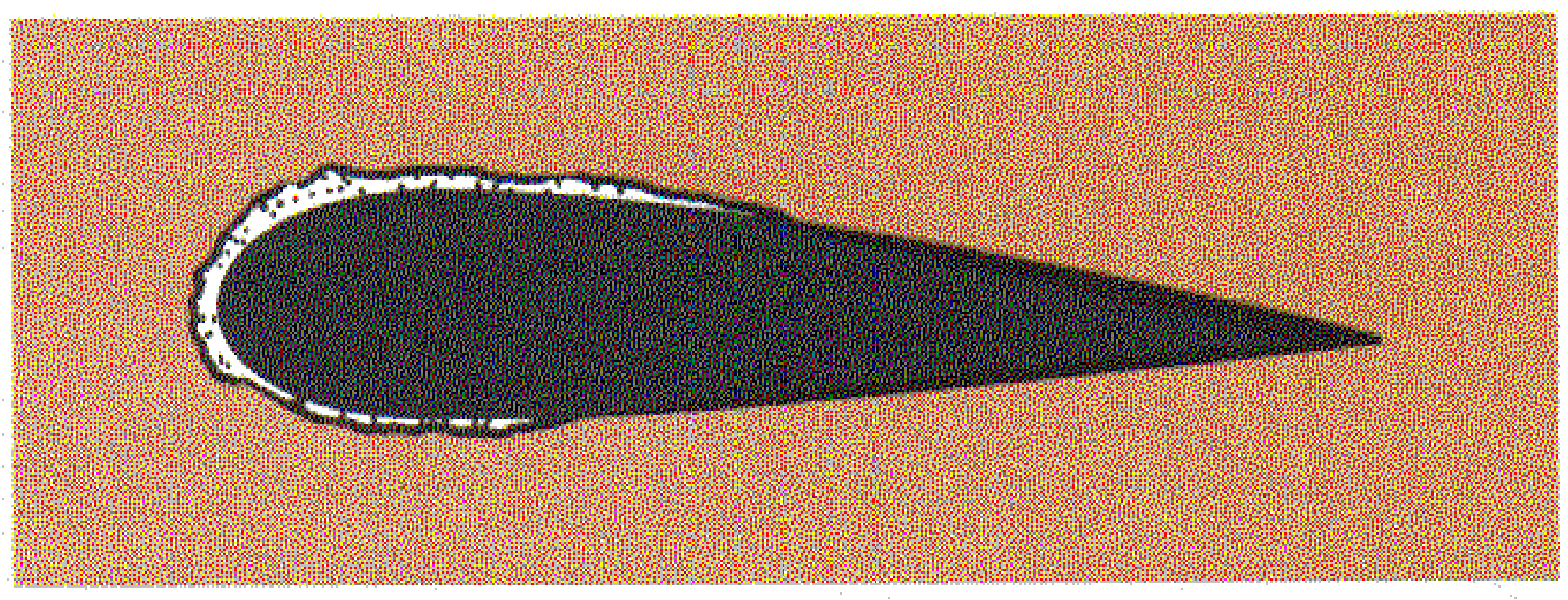

Figure 5. Rime Ice on Airfoil – Brittle and Frost-Like

structural icing is likely to occur. This is truly an anti-icing system, although it does have the capacity to operate as a deicer. Bear in mind before using the engine anti-icing system as a deicer that the engine compressor could sustain structural damage as ice breaks away from the air intake and is ingested by the engine. When activating or securing the engine anti-icing system, monitor the engine horsepower closely for indication that the engine anti-icing valves are operating properly.

CAUTION

> Anti-ice protection is not available to engines secured for loiter operations. Two or three-engine loiter in icing conditions may cause ice buildups in the feathered engine, leading to damage or possible engine failure upon restart. Two or three-engine loiter should not be used in conditions where visible moisture is present at ambient temperatures below +10°C, since there is a considerable drop in air temperature as it passes through the engine air inlet.

Both the propeller and the empennage ice control systems operate as combination anti-icers and deicers. Their operation is controlled automatically. The propeller deice system should be operated in conjunction with the engine anti-icing system. If ice has the chance to build up on the propeller before its deice system is turned on, the shed ice fragments might cause some airframe damage. The empennage deicing system should be operated whenever structural icing is evident.

For most efficient engine operation, use the wing ice control system as a deicing system. Allow ice to build up to about 1/2-inch on the wing leading edges before deicing them. Naturally, use of common sense also applies in these situations. Flying with a small buildup of ice for an extended period can cause the aircraft to perform as a "dirty" aircraft and consume as much as 25 percent more fuel.

The ice control system on each wing has three segments: inboard, outboard, and the center segment between the engines. To remove ice from the wing leading edges in the most efficient manner, first place the OUTBD wing ice control switch ON, then monitor the leading edge temperature indicator for a temperature rise and (if possible) observe the leading edges to ensure that the ice breaks away. When the ice has been removed from the outboard leading edges, turn the OUTBD switch OFF. Repeat the procedure for the center and inboard leading edge sections in that sequence. Normally, a 10°C rise (as reflected by the wing leading edge temperature indicator) is sufficient to remove ice from the wing leading edges. This procedure usually requires the control

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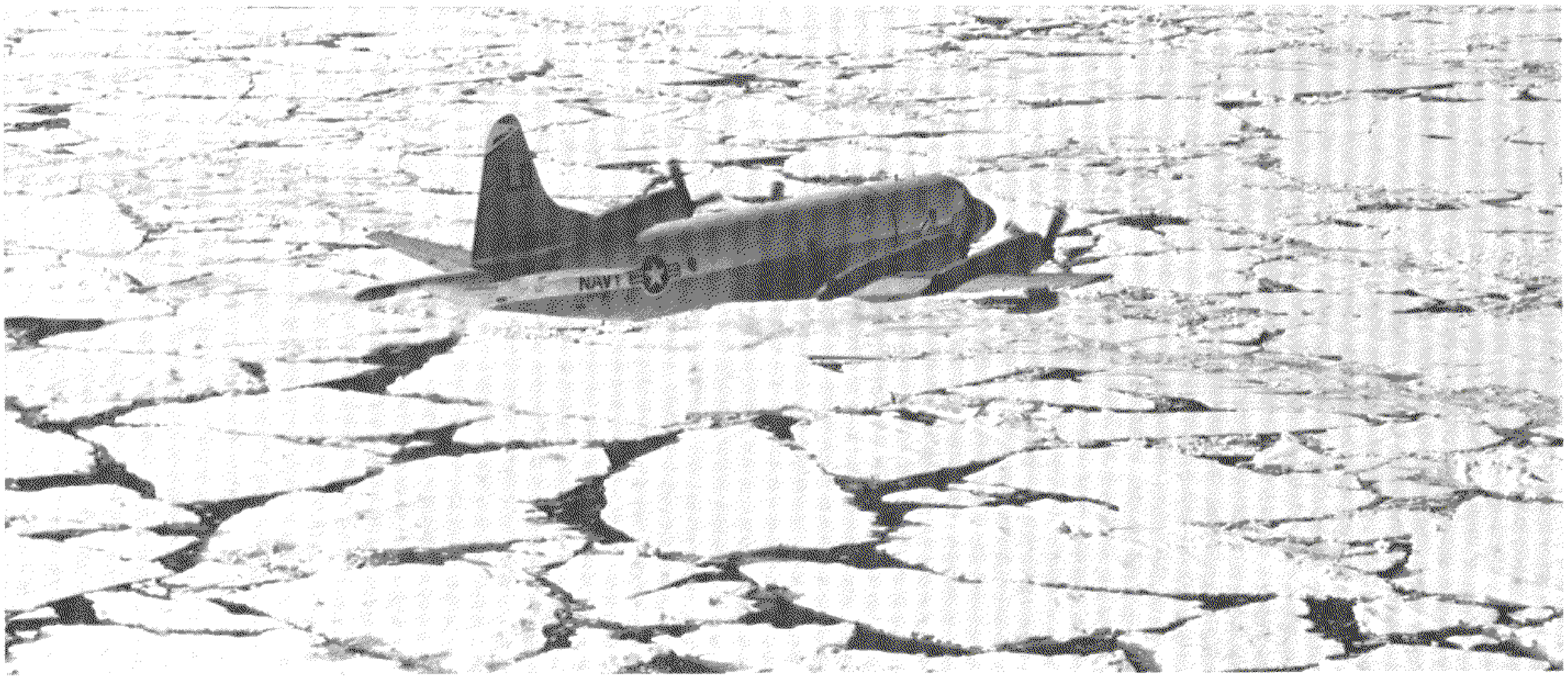

Photo by Jim Upton

switch for each pair of leading edge sections to remain ON for 20 to 30 seconds. When the ice has broken away from all of the wing leading edges, leave the ice control switches OFF until ice builds up sufficiently to repeat the cycle.

The aircraft is operated with the windshield heat on at HIGH power for all operating conditions. This serves the dual purpose of preventing ice accumulation on the windshield and maintaining the temperature of the laminated windshield panels' energy-absorbing vinyl ply within the optimum range. (This second function also meets windshield birdproofing requirements.)

The first signals that icing is beginning to occur are illumination of the ICING light on the center instrument panel, and the accumulation of ice below the windshield wiper. The onset of icing conditions can be recognized more quickly and evaluated by observing the windshield wiper and washer for ice buildup. These are also the first signals for immediate actuation of the engine anti-icing system.

TURBULENT AIR PENETRATION The aircraft should always be prepared for severe turbulence. Care must be taken to ensure that all loose gear is stowed in a safe place – preferably lashed to the deck – at all times. Make use of the search radar and any help available from ground radar to avoid precipitation and turbulence, and be alert for clear air turbulence while flying at altitude.

Areas where moderate to extreme turbulence is suspected should be penetrated at 220 KIAS. Crew members should be at their ditching stations, with hard hats on and seatbelts fastened to reduce the possibility of them sustaining injury. In light to moderate turbulence, crew comfort may be improved by reducing the airspeed to a minimum of 190 KIAS at gross weights up to 120,000 pounds or to a minimum of 1.52 V_S* if the aircraft gross weight exceeds 120,000 pounds. During light to moderate turbulence, limit use of the autopilot to attitude control only.

THUNDERSTORMS The thunderstorm is one of the most difficult weather phenomena that the pilot has to cope with, because it presents an unpredictable hazard. Although the P-3 airframe exceeds the wing strength of any aircraft in its category, flight through a severe thunderstorm may incur ice, hail, or lightning strike damage that is

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**Stall speed*

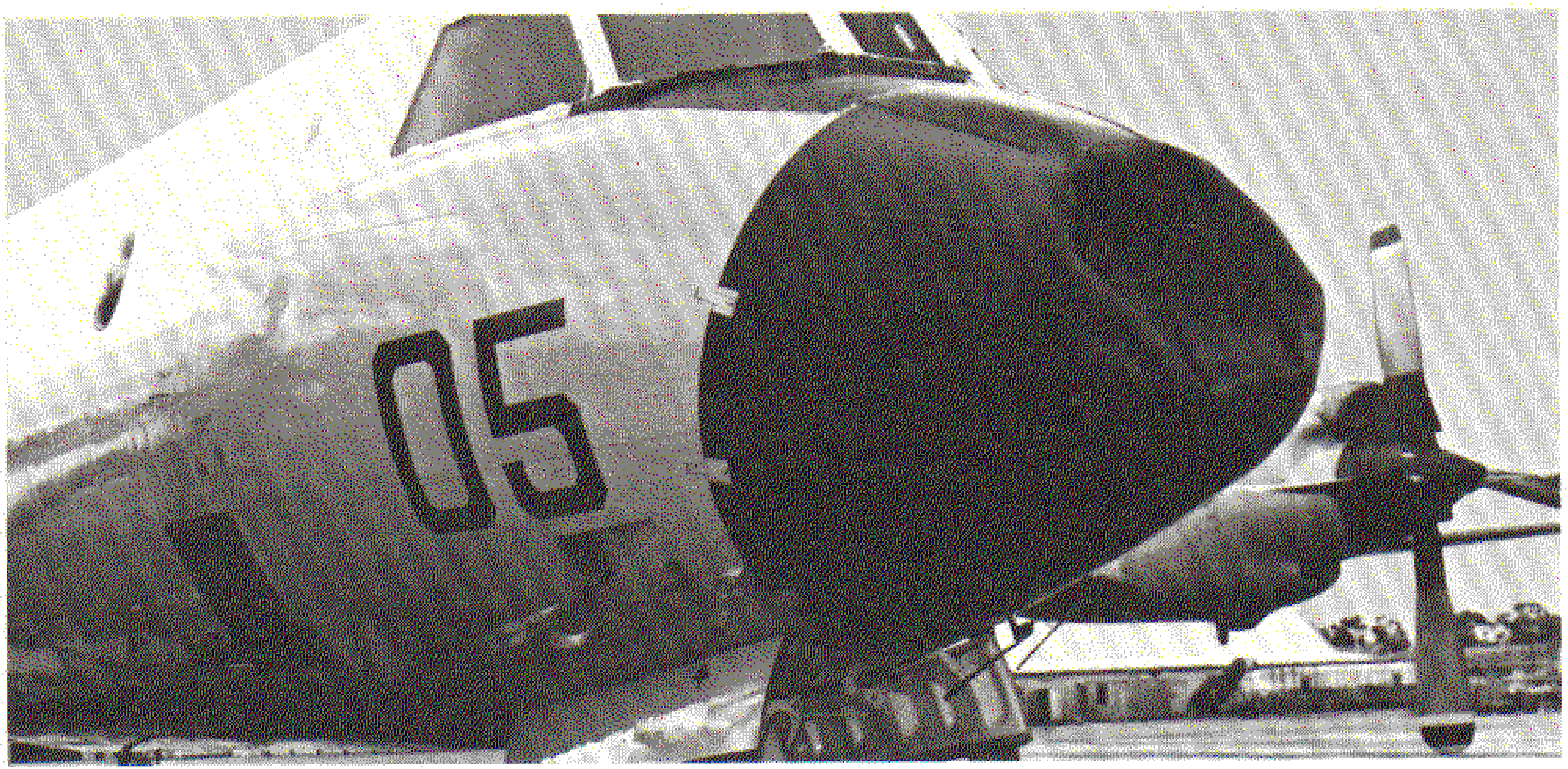


Figure 6.
In-flight Hail Damage to Radome and Wing Leading Edges of a P-3 Aircraft

Photos courtesy of Royal Australian Air Force

very expensive to repair. Figure 6 shows in-flight hail damage sustained by a P-3 aircraft. Crewmembers also may suffer serious injury from unexpected encounters with severe or extreme turbulence.

In peacetime situations, there is no good reason to motor through a thunderstorm. However, during combat, deviation around thunderstorms might not be prudent. If flight through thunderstorms between 10,000 and 20,000 feet or other areas of extreme turbulence cannot be avoided, make maximum use of weather forecasts, on-board radar, and en route radar facilities to determine the storm area of least intensity.

There is no 100 percent "safe" altitude at which to penetrate a thunderstorm. Flight levels near or slightly above the freezing level seem to contain the maximum concentrations of heavy icing, hail, turbulence, and the majority of lightning strikes. If the storm cannot be circumnavigated, avoid flight at the freezing level by as wide a margin as possible. Fly either above or below the freezing level, consistent with the aircraft's high altitude performance or with terrain clearance considerations.

If by chance you *have* penetrated a thunderstorm, do not allow turbulence, hail, or lightning to cause panic. Remember, you are in an aircraft that is proven to be very strong. Devote all of your attention to flying the aircraft. Hold a level attitude, because attitude is the primary reference during flight in areas of extreme turbulence. Severe vertical gusts may cause appreciable altitude changes. Maintain the desired attitude, and do not chase the altitude and vertical speed indicators. There is an obvious correlation between precipitation and vertical gusts. The intensity of turbulence varies directly with the intensity of precipitation.

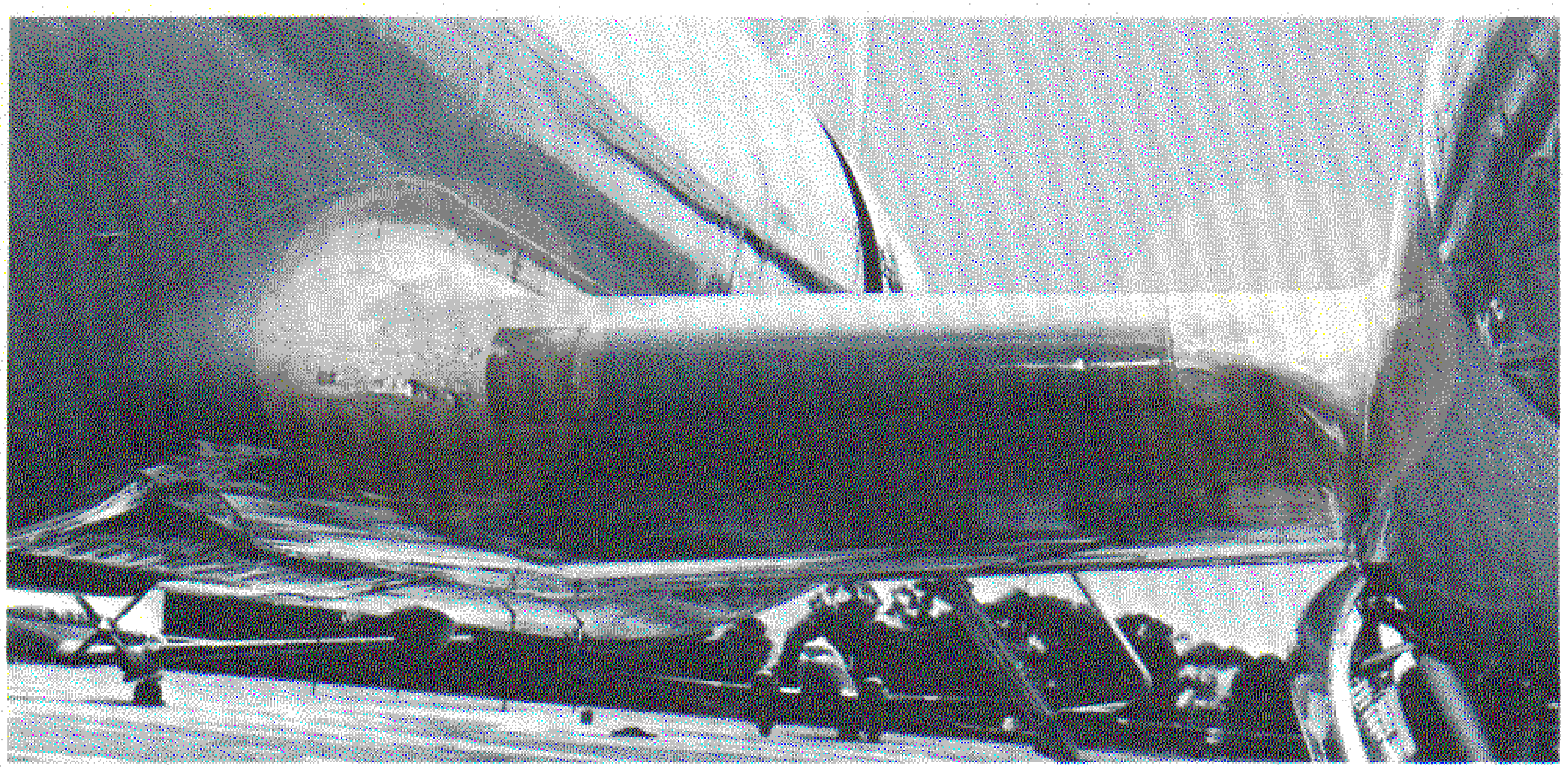
TABLE 2

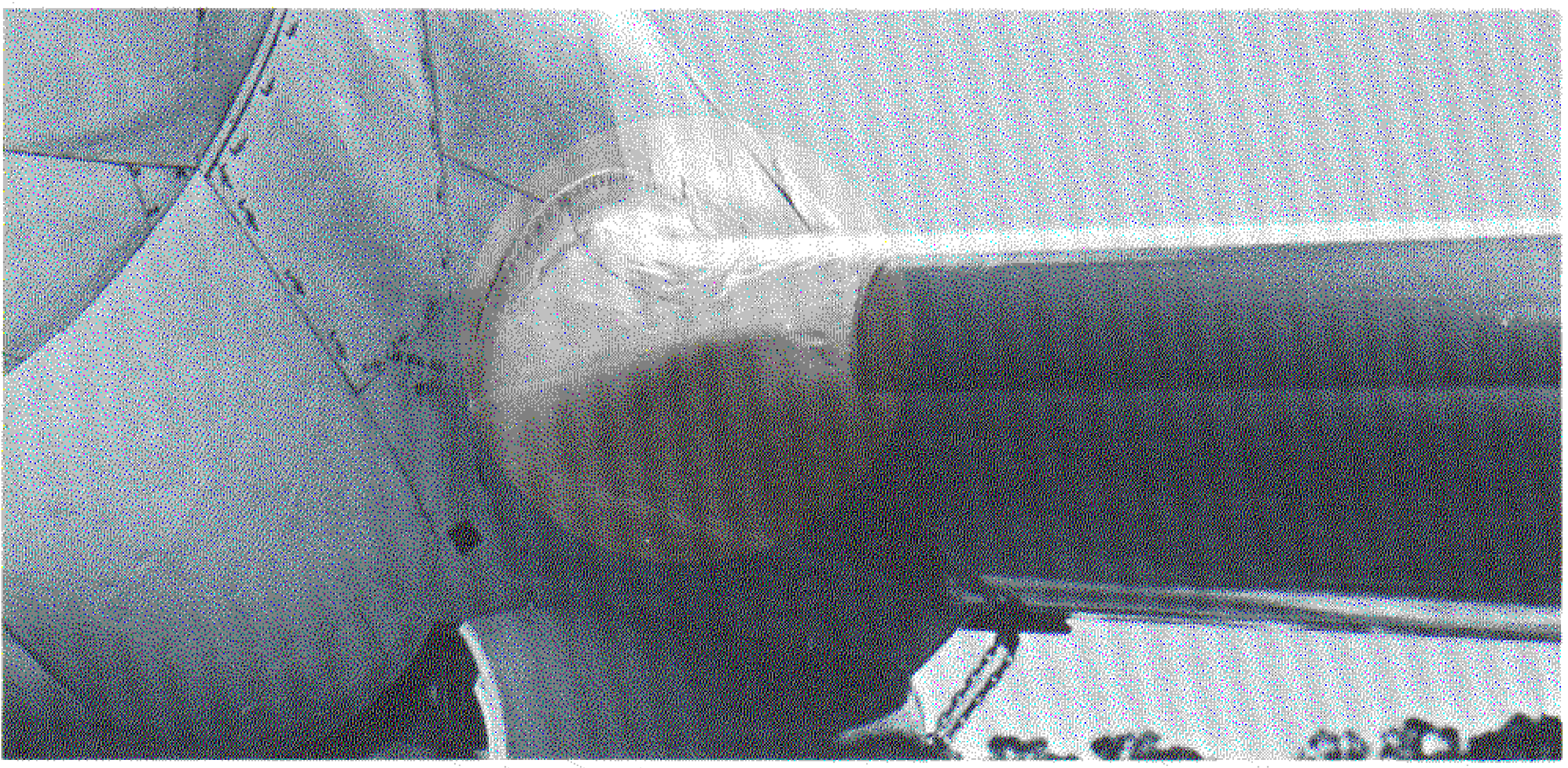
USAF RUNWAY CONDITION	USN EQUIVALENT BRAKING ACTION	PERCENT INCREASE OF LANDING ROLL
00 to 05	Poor	100% or More
06 to 12	Fair	50% to 99%
13 to 25	Good	0% to 49%

APPROACH

Find out as much as possible about the weather and runway conditions at your destination. The sooner you find out, the sooner you can decide who will be in what seat for landing. Flight service stations will gladly update your terminal weather report while you are enroute. Check with the tower or approach control at your destination for the runway conditions when you are close in. Table 2 lists the U.S. Air Force and U.S. Navy equivalents pertaining to runway condition and braking action.

Approaches and landings in cold weather areas can have little resemblence to normal approaches and landings. Conducting an approach in icing condi-





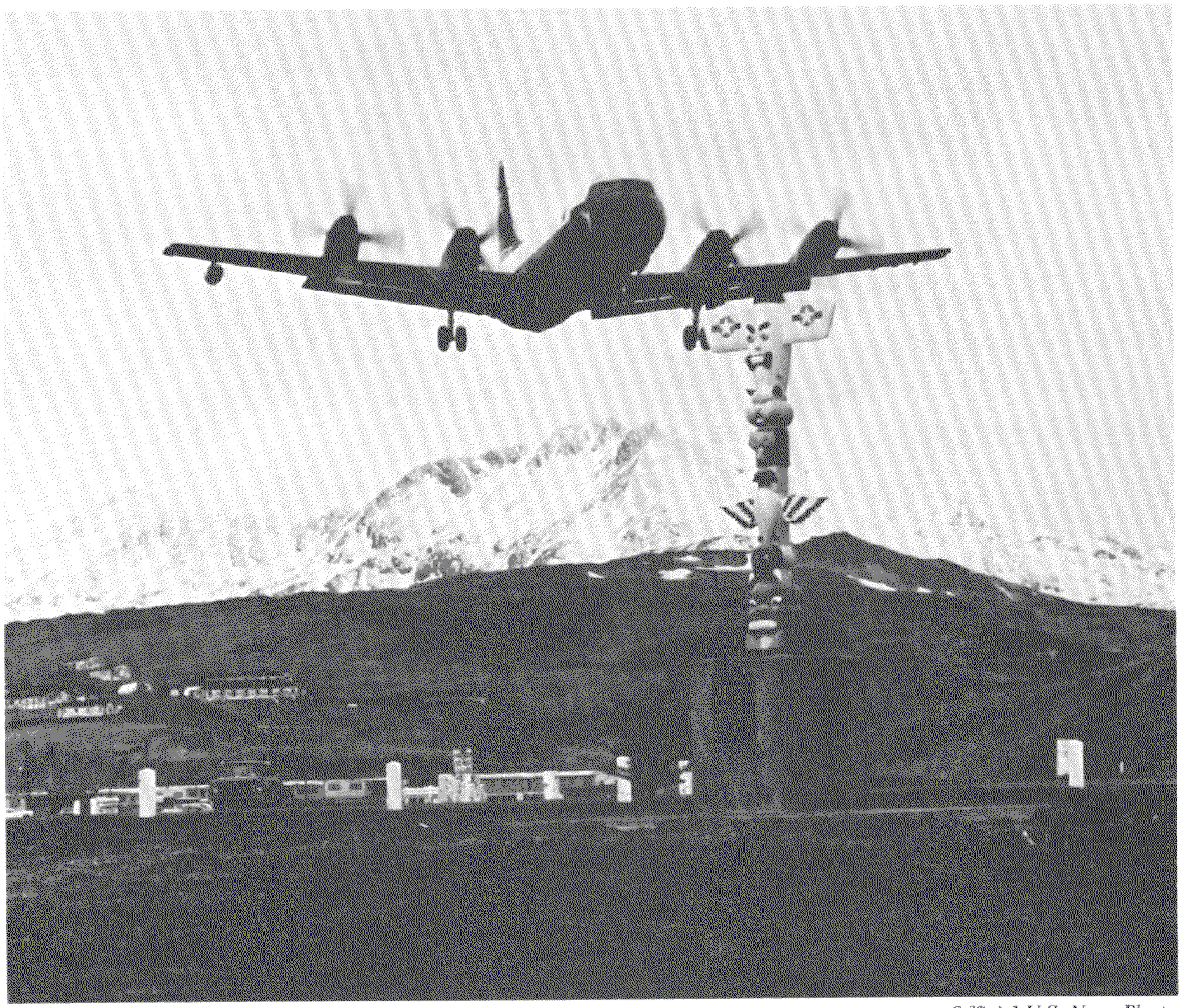
tions may require you to hold the landing gear and flaps "up" until just prior to turning into final approach in order to avoid excessive ice buildup and drag. *Watch this procedure, it involves breaking habit patterns.* On long final approach, lower the landing gear and flaps and reduce airspeed to the normal approach speed. In gusty wind conditions, approach airspeed may be maintained 5 to 10 knots higher than normal, but the speed at touchdown should be normal.

If the final approach is made through icing conditions, cycle the wing deicers to clear the wings of ice. Engine anti-ice may be used through completion of the landing. Be alert for possible negative torque system (NTS) operation with engine anti-ice and wing deice selected ON, and the power levers selected to FLIGHT IDLE.

There is some tendency to be fast on the approach. Airspeed and altitude should be closely regulated so that the end of the runway is crossed at 1.3 V_S and 50 feet in order to touch down in the first 1,000 feet of the runway. An additional 50 feet over the threshold can increase the touchdown point some 500 to 700 feet further down the runway. Excess speed of 10 KIAS can increase the stopping distance on ice by another 1,000 feet. If you cannot touch down in the first 1,500 feet of an 8,000 foot runway, *wave off* and try again. Aircraft weight is also a factor that merits careful consideration before approach, because it too will affect the stopping distance.

A condition known as "whiteout" can occur when making an approach in a heavy snowfall and the ground already has a layer of snow on it. No horizon is discernible and there are few depth perception cues. It is far better to *wave off* this one too.

Blowing snow from snowbanks can also be a hazard prior to touchdown. The runway may be obscured during the flare. Again, stand by for a *wave off.*



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LANDING

Land into the wind, if possible. For each knot of headwind or tailwind, the landing distance will be decreased or increased by approximately one to two percent. Any crosswind conditions will increase your landing rollout on a snow or ice-covered runway because asymmetrical power must be used to maintain aircraft directional control after touchdown, which reduces the amount of reverse thrust available for braking. Rollout distance is further increased on slippery runways because the brakes are relatively ineffective.

If crosswinds are present, try to use the longest runway with the crosswind *from* your right. The wind component will help compensate for the left vectoring effect from engine power torque. The maximum crosswind component for landing at which a P-3 has been flight-tested is a wind of 35 knots at 90 degrees to the runway. These values have been adopted as the maximum crosswind component for landing a P-3 under otherwise ideal conditions. When the runway surface is slippery, the maximum allowable crosswind component for landing a P-3 is reduced considerably. Anything greater than a 20-knot crosswind on ice-covered runways is considered too hazardous for attempting landing.

Land on the runway centerline, allowing ample runway surface for lateral aircraft movement during rollout. Use rudder, aileron, and asymmetrical thrust to maintain directional control during rollout. Do *not* use nosewheel steering, because it is generally ineffective on icy or slippery surfaces and can result in misalignment of the nosewheel.

When using asymmetrical thrust to maintain directional control, ease the power levers into the BETA range slowly and apply asymmetrical thrust as necessary. If maintaining directional control becomes a problem, move the power levers ahead to GROUND START to stabilize the aircraft heading, then slowly bring the power levers back into REVERSE. Keep in mind that use of high-power reverse thrust on snow-covered runways may impair forward visibility at lower ground speeds (approximately 50 knots, or less) by blowing loose snow in front of the aircraft. Use of asymmetrical thrust for directional control with four engines operating will reduce the effect of reverse thrust to that of approximately three

engines. For three-engine landings on ice or snow-covered runways, plan for a total negative thrust equal to that of two engines.

As the aircraft slows, test its braking effectiveness by applying the brakes symmetrically and with discretion. *Do not lock the brakes.* The aircraft's brakes may be used on snow-covered surfaces with fair to good effect. However, if the wheels are rolling on an icy surface and the brakes are applied, they may lock inadvertently without your knowledge. Should the wheels subsequently encounter dry spots on the pavement while the brakes are locked, the result can be out-of-round or blown tires.

After rollout, bring the airplane to a complete stop before clearing an icy runway. The consequence of neglecting this precaution could be a smooth, gliding slide off the runway. Clear the runway by using asymmetrical thrust for directional control as you taxi the airplane to its parking spot. As mentioned earlier under "Start and Taxi" and earlier in this section, nosewheel steering is generally ineffective on icy surfaces and attempts to use it can result in a misaligned nosewheel.

After landing on a snow or slush-covered runway, leave the wing flaps in the position used during landing until ground personnel can clean the debris from the flap leading edges and flap tracks. The P-3 NATOPS Flight Manual restricts flap retraction above the Takeoff/Approach position until debris has been cleaned from these surfaces, except after takeoff.

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POST FLIGHT

Park the aircraft in a position so that the ramp tie-down pads are easily accessible. Be certain that the tie-down pads are free of ice before tie-down is attempted. If possible, the aircraft should be parked with its wheels on mats to prevent the tires from freezing to the pavement. Do *not* set the parking brakes in freezing weather (or when the brakes are overheated). During gusty wind conditions, station the crew forward in the aircraft until the nose tie-downs are secured. This will help keep as much weight as possible forward during tie-down, to prevent the wind from tipping the aircraft on its tail. Aircraft tie-down requirements can be summarized as follows:

- No aircraft tie-down is required for wind velocities up to 45 knots, under wet ramp conditions with *no* ice present. This condition assumes that the parking brakes are set, the wheels chocked, and the control surface boosters are engaged.
- Under icing conditions, or under all conditions (including icing) when the wind velocity is from 45 to 60 knots from any direction, use a one-point tie-down at both the nose left and right mooring fittings, a four-point tie-down at each wing mooring eye, and ensure the control surface boosters are engaged. See Figure 7.
- Under all conditions when the wind velocity is from 60 to 100 knots from any direction, use a double-point tie-down at both the nose left and right mooring fittings, a one-point tie-down at each wing mooring eye, a three-point tie-down at the empennage left and right mooring fittings, and ensure the control surface boosters are engaged. See Figure 8.

Provisions for mounting mooring fittings on the aircraft are located on the left and right of the fuselage nose at Fuselage Station 288; at the left and right wing jack points at Wing Station 168; and left and right on the fuselage below the empennage at Fuselage Station 1204. Note that the aircraft can be flown with the mooring fittings attached to their mounting points; however this increases drag and will result in increased fuel consumption. Whenever the mooring fittings are removed for flight, their attachment points at Fuselage Station 288 must be plugged to prevent loss of cabin pressurization. Use Fuselage Station 288 jack fitting plug Part Number 925237-3 for this purpose, eight plugs per fitting.

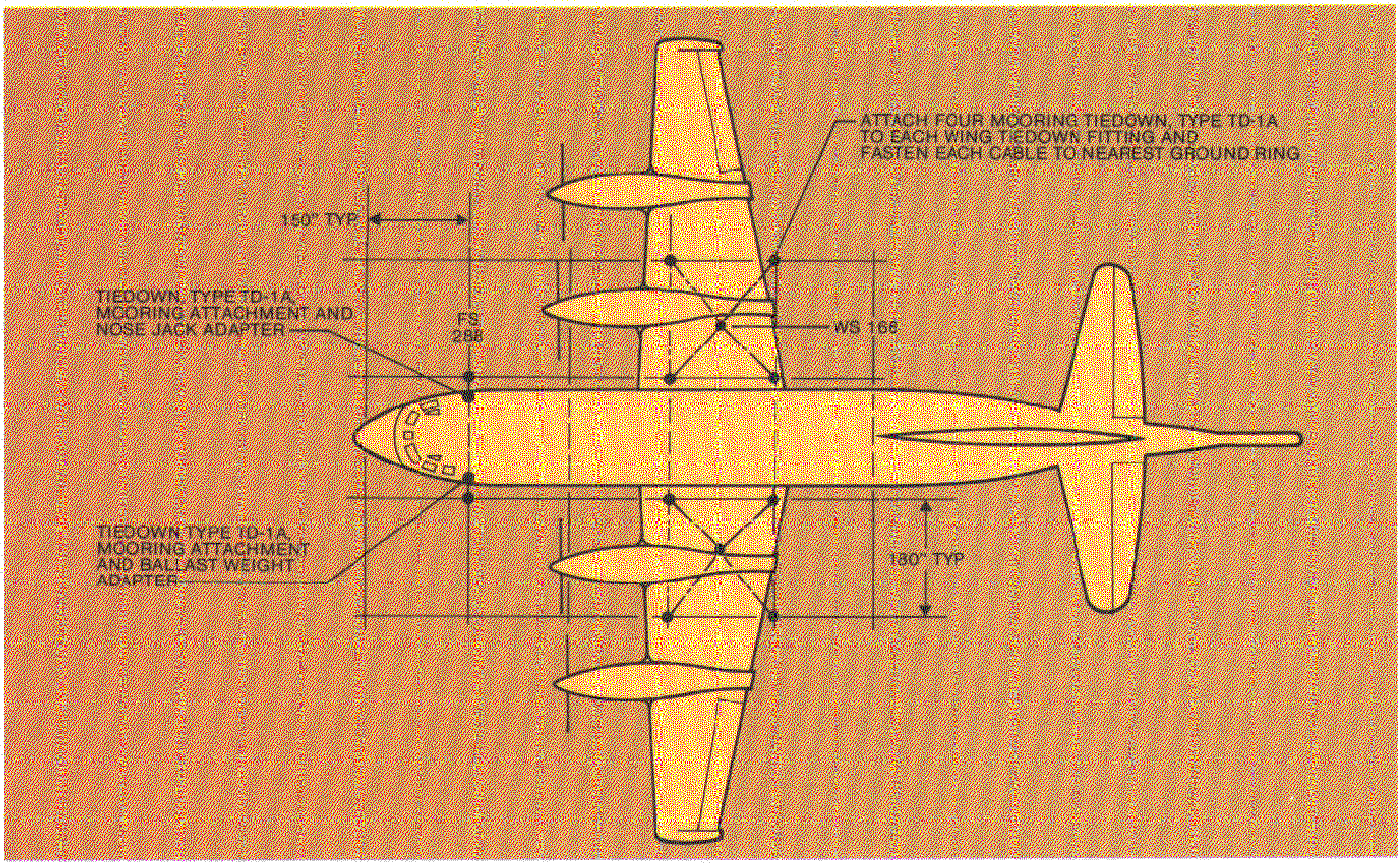

Figure 7. Mooring for Wind Velocities from 45 to 60 Knots

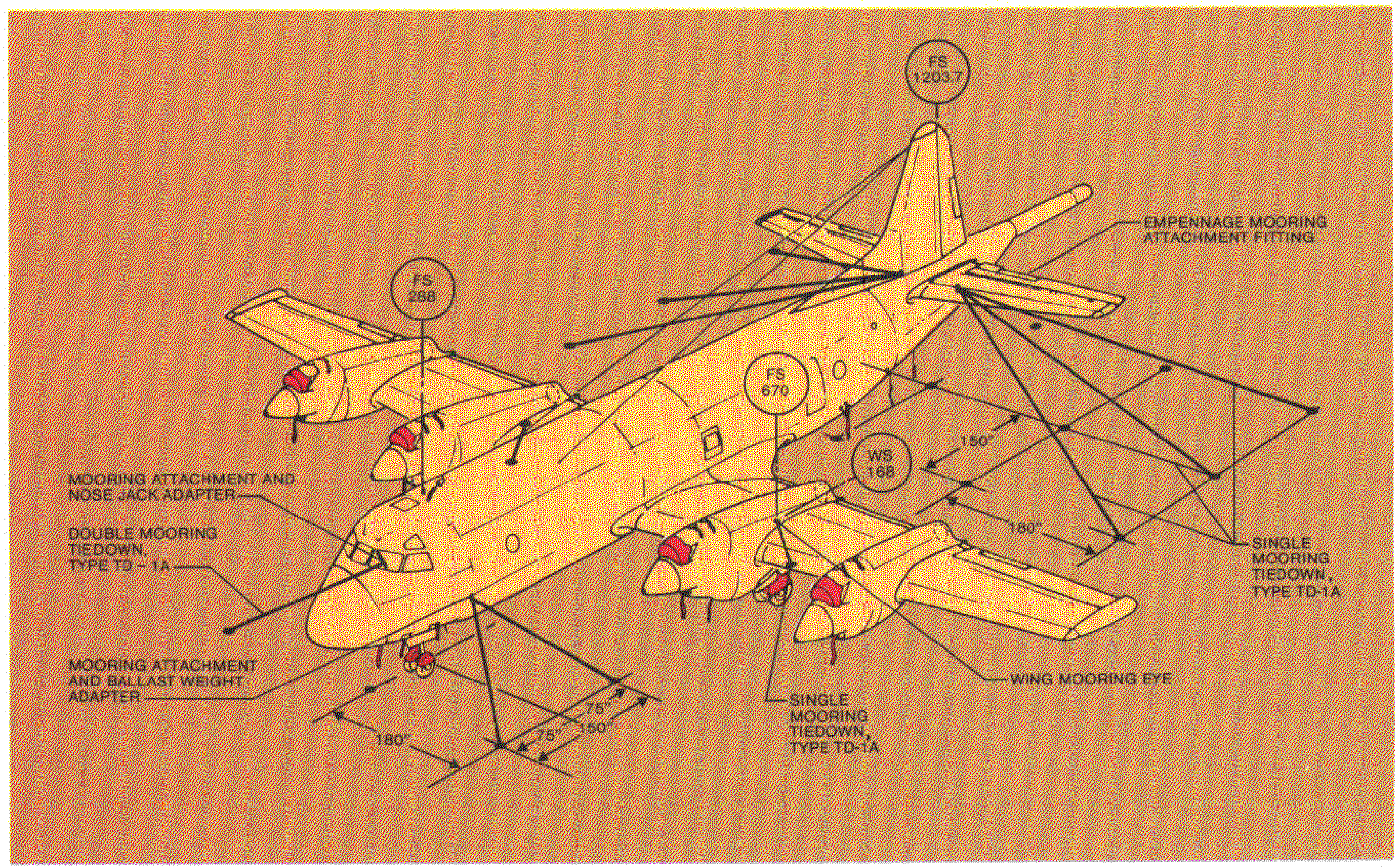

Figure 8. Mooring for Wind Velocities from 60 to 100 Knots

All of the tie-down conditions require that the control surface boosters remain engaged (boost on) when the aircraft is parked outside. When engaged, the control surface boosters supply sufficient resistance to gust loads to prevent violent control surface movement. The resulting control surface movement caused by winds will be slow and controlled, without need for mechanical restraints.

In strong wind conditions, secure the propellers in the START blade angle position (approximately 0 degrees) after engine shutdown. The NATOPS Flight Manual states that it is neither necessary nor desired to feather the propellers in order to prevent them from windmilling in strong wind conditions. Subsequent unfeathering of propellers before start could damage propeller internal components after coldsoaking.

When the engines have been secured and the propeller blades have been positioned properly, install all protective covers and plugs. Remember, if an engine air intake cover is blown off, any subsequent accumulation of ice or snow must be removed from the air intake before the engine is started. Since this is a time-consuming task, ensure that the cover is installed securely. Equal care should be observed during installation of the other protective covers and plugs.

Drain water condensation from fuel, hydraulic, and oil sumps, and drain all water lines to prevent accumulated water from freezing and perhaps from causing damage. Also, in extremely cold weather, remove the battery and all fresh and waste water containers to prevent their fluid contents from freezing.

Ensure that the landing gear oleo struts are wiped down with a cloth soaked with hydraulic fluid. This will facilitate removal of any accumulations of ice or snow on their surfaces the next time that the aircraft is preflighted. Door latches, doorjambs, and all removable hatches should be wiped with a glycerin solution to prevent them from freezing, then all doors and hatches should be closed. At this time, a deicing solution may be applied to the aircraft exterior to prevent snow from sticking to its surfaces.

One final thought. Watch that icy ramp after exiting the aircraft.

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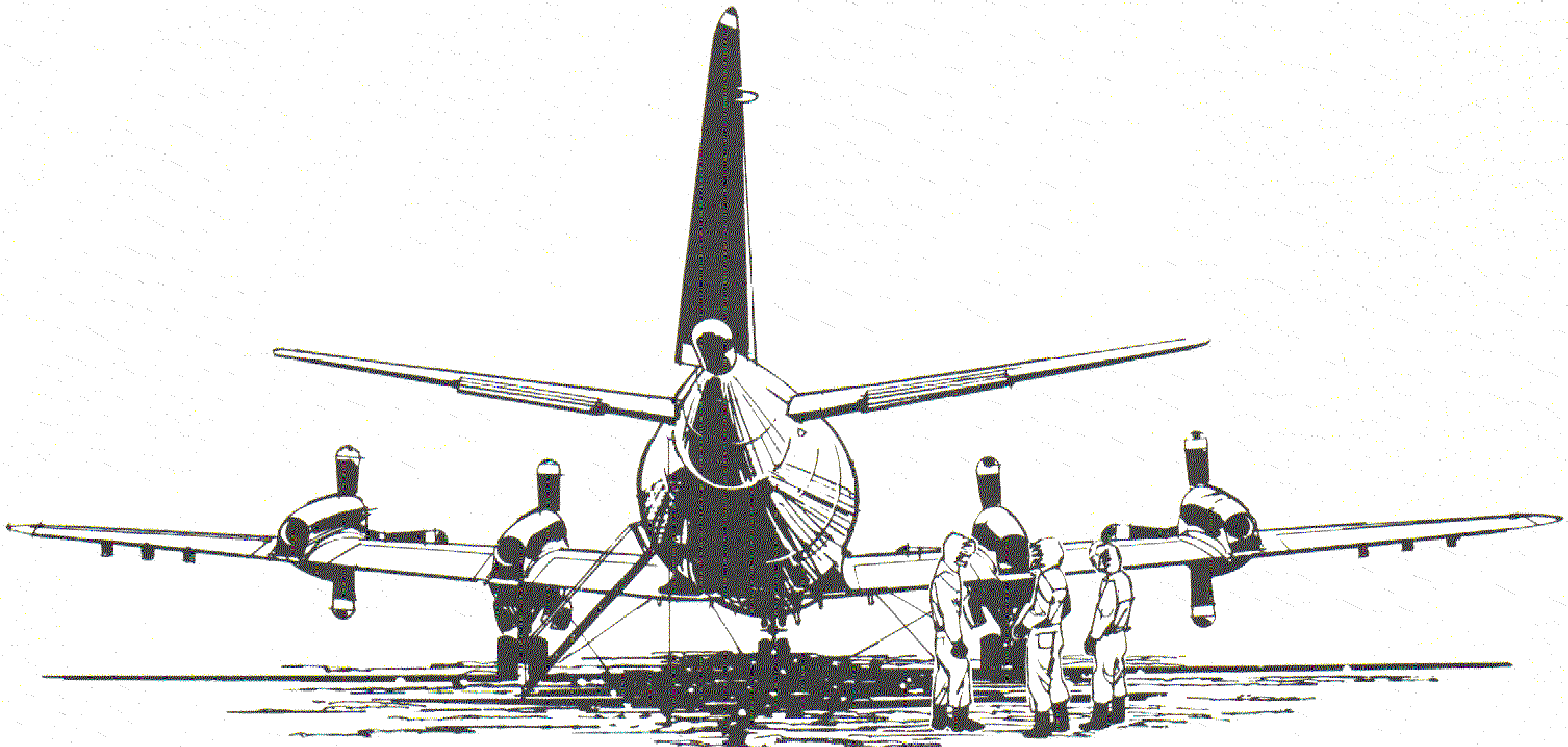

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