SERVICE LETTER

Service Letter No. 327

December 28, 1959

TO: All Distributors, Dealers, Owners and Operators

SUBJECT: Federal Aviation Agency Bureau of Flight Standards
Release No. 434

Attached to this Service Letter is a copy of the subject Federal Aviation Agency release pertaining to flight control hazards and protection from icing. We consider this information of such importance to the operators of our aircraft that it should receive full and complete distribution by your organization to the field.

Very truly yours,

PIPER AIRCRAFT CORPORATION

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Service Spares Manager

RM:mm
enclosure

FEDERAL AVIATION AGENCY
WASHINGTON 25, D. C.

November 2, 1959

BUREAU OF FLIGHT STANDARDS RELEASE NO. 434

SUBJECT: Flight Control Hazards and Protection from Icing

The purpose of this release is to point up to general operators the basic hazards of icing conditions in flight for piston engine airplanes, the kind of protection required, and the operational practices for maintenance of flight control and a safe operation.

General

Accident and critical incident reports reveal that many private and professional pilots may not be aware of the many ways in which icing can seriously affect the pilot's ability to maintain flight control during instrument flight. It is also known that many operators are unaware of the kind and amount of protection needed to cope with light, moderate, or heavy icing conditions.

External icing (impact, rime, clear, etc.) is most probable when flying in air with visible moisture (cloud, drizzle, rain, or wet snow) and at temperatures from 32°F to 20°F. Even in air temperatures as low as -30°F, there are many known cases of encountering heavy icing when flying in such supercooled moisture conditions. Depending upon the degree and form of moisture present, and upon the air temperature, ice accretions on an airplane's wing and other external surfaces may form slowly or with alarming and dangerous rapidity.

Internal carburetor system icing is most likely to occur in temperatures between 40°F and 60°F but can occur in air temperatures as high as 90°F. It is not necessary to have visible moisture present for this type of icing. The particular temperature range and the degree to which a carburetor is subject to icing is dependent upon its particular design and installation. For this reason, the pilot should refer to the airplane manufacturer's manual on the operation of the engine for detailed information on how to cope with carburetor icing. However, there is one aspect of carburetor icing that has been revealed in more recent accident and incident reports that will be covered below, namely, high altitude carburetor icing.

General aircraft operators must reply upon the U. S. Weather Bureau's forecasts and reports to predict icing conditions ahead. The definitions of these conditions as used by that Bureau are as follows:

> Light icing--An accumulation of ice which can be disposed of by operating de-icing equipment, and which presents no serious hazard. Light icing will not cause alteration in speed,

altitude, or track.

Moderate icing--An accumulation of ice in which de-icing procedures provide marginal protection; the ice continues to accumulate, but not at a rate sufficiently serious to affect the safety of the flight unless it continues over an extended period of time.

Heavy icing--An accumulation of ice which continues to build up despite de-icing procedures. It is sufficiently serious to cause marked alteration in speed, altitude, or track, and would seriously affect the safety of the flight.

FLIGHT HAZARDS FROM ICING

The basic and critical icing hazards in flight are as follows:

1. <u>Icing of outside pitot/static pressure sources and venturi units</u>.

   a. Erroneous airspeed, altimeter and rate of climb indications.

   Whenever the pitot or static air pressure sources or lines freeze fully or partially, the airspeed, altimeter, and rate of climb instrument indications will no longer be correct. This grave situation can cause the pilot to exceed the airplane's limitations unknowingly, to break up the airplane in flight, or to fly unknowingly into the ground.

   b. Erroneous direction and attitude indications.

   Those airplanes that utilize an outside venturi unit to provide power for vacuum driven gyros, and which are not located within the engine's exhaust gases, are very susceptible to ice accretions on the venturi tube. This in turn reduces the vacuum and the gyro will no longer give accurate attitude or direction indications.

   (The pilot must have at least one properly functioning gyro instrument to maintain flight control on instruments.)

2. <u>Accumulation of dangerous ice loads on the wing and tail surfaces</u>.

This situation changes the airflow and reduces the available lift while increasing the load the wing has to carry. It can also jam flight control surfaces if the buildup occurs near hinge points or between fixed and moveable flight surfaces. In extreme cases, the combined effects of ice load and loss of lift will force a plane down. Further, the wing will stall out at considerably higher than normal stall speeds.

3. <u>Accumulation of ice on propeller surfaces</u>.

This situation creates a serious vibration problem and a loss of propeller effectiveness. The first indication to the pilot of propeller icing will be cycles of increasing vibration, followed by a sudden vibration increase as the ice from one propeller blade breaks free, followed by a period of vibration-free operation after all ice is thrown free from both propeller blades. The situation also causes a decrease in airspeed at a constant altitude and throttle setting. On multiengine airplanes, the pilot may hear chunks of ice impinge on the side of the fuselage as they break free of the vibrating propeller blades.

4. Carburetor icing and air intake clogging.

Either condition results in loss of power. Carburetor icing is more difficult to control at high altitudes. This is because the available heat to cope with any icing is considerably less at altitude than at sea level for airplanes with nonsupercharged engines. A sea level engine can only develop approximately 75% power with full throttle at 8000 feet. Available carburetor heat may be reduced to an even lower percentage of that which would be available near sea level.

Carburetor air intake icing is usually the result of snow or sleet impinging on the intake screen. Such an ice buildup starves the engine for air. Carburetor air must then come from some alternate protected source to maintain power.

5. Windshield icing.

The loss of windshield visibility from icing is most hazardous to the pilot when attempting an approach and landing. An openable window to see forward or a means for de-icing the windshield is needed to provide the necessary forward vision at such times.

6. Radio and pitot mast icing.

Ice buildup on these masts can create air disturbances and bending loads for which they may not have been designed. If so, the mast may bend or break off. The pilot will then be without radio or have erroneous airspeed/altimeter/rate of climb indications. It is also possible for the "run-back" from a heated pitot tube to freeze and cause an ice buildup on the mast that can adversely affect the air flow functioning of the pitot and static pressure system.

There are also two other possible icing hazards, namely; impact or run-back freezing of (a) the controls for the carburetor air preheater and the throttle, and (b) a fuel tank vent becoming clogged with ice which would in turn cause fuel starvation. Fortunately, these two hazards do not seem to materialize very often. Frequent checking of the throttle and heater controls for freedom of movement is a method of knowing that they remain operative. If fuel starvation does occur from vent icing, switching to an alternate tank may provide power for a limited time, or if a common vent line is accessible to the pilot, it may be possible to sever it to provide an emergency vent.

EQUIPMENT PROTECTION FOR COPING WITH ICING

To be able to cope with inflight icing situations, the pilot should have operative equipment on the airplane as follows:

1. Vital instruments (speed, altitude, direction, attitude).

   a. An airspeed pitot tube heater and an alternate static air source for the airspeed/altimeter/rate of climb indicator system.

   b. Heat from engine exhaust pipe(s) impinging on any venturi tube(s) used to supply vacuum power for air operated gyroscopic instruments or, an alternate vacuum source that is power driven. (One vacuum and one electrically driven gyroscopic instrument provide equally effective and excellent protection against malfunction of any type.)

2. Inflatable wing and tail surface boots or a heat duct de-icing system for flight surface protection.

3. Alcohol slingers or electrically heated boots for propeller surface protection.

4. A carburetor air preheater device and a sheltered alternate air intake source for the carburetor.

5. Alcohol or a heat system to de-ice the windshield, or an openable forward window that cannot freeze shut to protect forward vision.

6. Alcohol, inflatable boots, or electrically heated boots for pitot and radio masts that may be susceptible to ice buildups for protection of the navigational radio aids and the airspeed/altimeter/rate of climb system.

Temporary preflight protection of external surfaces from possible inflight icing can also be provided by application of one of the commercial anti-ice preparations. When applied to wing surfaces, windshields, propeller blades, etc. in accordance with the manufacturer's instruction, a pilot may expect the airplane to stay free of any serious ice buildup for a reasonable period of time on the surfaces so protected. However, the protection is temporary, the pilot should not expect protection beyond the period of time the manufacturer specifies for his product.

OPERATIONAL PRACTICES

As can be readily seen, icing protection is needed for all of the above areas that are vital for maintaining flight control in any actual icing condition while flying on instruments. The degree of protection is dependent upon the amount and rate of ice accretion with which the de-icing or anti-icing equipment can cope. At best, the de-icing equipment that is usually provided on current models of nonair-carrier airplanes cannot be expected to cope with heavy or prolonged moderate icing conditions. The latter can be expected to tax the equipment beyond its capacity.

Thus, pilots of airplanes which are equipped with all of the above de-icing provisions should always strive to avoid heavy and moderate icing conditions. <u>If heavy icing is encountered unexpectedly or unavoidably, prompt action must be taken to get into more favorable flying weather conditions.</u> To procrastinate or delay such evasive action, accident investigation reports show, is to invite a loss of flight control and with very little, if any, warning.

<u>Should a pilot find himself in icing conditions without full de-icing equipment, his primary concern should be to use the equipment he has and to get to non-icing air as quickly as is safe.</u> The following basic operational practices or flying habits should be observed:

A. <u>Avoiding Conditions Conducive to Icing.</u>

1. Monitor closely all weather reports in the vicinity, paying close attention to temperatures at the ground and any reported or forecasted icing condition aloft. A $3^{\circ}F$ to $4^{\circ}F$ temperature drop per 1000 feet above the ground may be used to approximate temperatures at flight altitude above ground stations, if unknown.

2. Monitor closely the outside air temperature gage for temperatures favorable to external icing.

3. Follow a plan of safe evasive action which utilizes the following principles:

   a. In clouds not near a cold or warm front, a lower altitude--if altitude permits--is usually warmer and any accumulated ice will melt. A higher altitude is usually colder and the visible moisture will likely be in a frozen state which can not cause any further ice buildup. Any accumulated ice will gradually sublimate (vaporize) when getting into dry colder air.

   b. In freezing precipitation near a warm front, a higher altitude will usually be warmer (warm air usually overruns cooler air near the ground). If at sufficient altitude, it may also be possible to descend into warmer air near the ground with non-icing conditions.

   c. In clouds or precipitation near a cold front, advantage may be taken of the difference in temperature ahead of and behind such a front and the tendency of the cold mass of air to wedge under the warmer air ahead of the front. Thus going towards a cold front in temperatures conducive to freezing, a higher altitude will likely avoid icing both ahead and behind the front.

4. Flight speed and attitude indications should be closely watched and double checked. Cross checking the artificial horizon or attitude gyro instrument with the airspeed indicator and the altimeter, is a means of making certain that ice is not affecting the accuracy of airspeed/altimeter/rate of climb indications. Maintaining a basic attitude is essential to avoidance of a stall or excessive flight speeds. Cross checking an electrically operated gyro's indications with those of a vacuum operated gyro is also a check on the accuracy of their indications.

   Note: At least five cases are known involving three current makes and models of multiengine airplanes in which the airspeed/altimeter/rate of climb indications became dangerously in error due to rain and moisture freezing in flight as the airplane climbed into freezing temperatures. In another known case involving another multiengine model that had a modified pitot mast installation, an ice buildup on the pitot/static head mast caused dangerous airspeed/altimeter/rate of climb indications from the disturbed airflow effects on the static pressure opening.

B. <u>Emergency Icing Conditions</u>

1. If an ice load is accumulated that makes climbing to a higher altitude difficult or maintenance of altitude impossible, an emergency descent is mandatory and flight control must be maintained with primary emphasis given to airplane attitude and keeping a safe flight speed above the airplane's higher stall speed with such an ice load. If a landing is necessary, such speed must be maintained to touchdown.

2. In an emergency while flying on instruments, the pilot should rely on:

   a. The attitude or artificial horizon gyro instrument to avoid a disastrous dive or stall

   b. The turn indicator, directional gyro, and attitude gyro to keep the airplane from entering a disastrous spiral, and

   c. Breaking out the glass in the altimeter or rate of climb instrument to get an emergency alternate static source which will give approximate altitudes, rates of climb or descent, and airspeed indications when the normal static pressure source has frozen.

In summary, pilots should avoid all heavy and moderate icing conditions, proceed with caution into areas where light to moderate icing is forecast, and should not engage in any instrument flight in air conducive to icing without having full de-icing equipment for the items vital to the maintenance of flight control. The vital areas of concern are: (1) speed, attitude, direction instruments that are dependent on the pitot/static pressure systems and venturi gyros, (2) wing and tail surfaces, (3) propeller surfaces, (4) carburetor air fuel mixture and air intake, (5) windshield forward visibility, and (6) any radio or pitot tube masts that may be seriously affected by any ice buildups.

B Pettersen

for William B. Davis, Director
Bureau of Flight Standards

DISTRIBUTION: AIR 3, 6, 8, 9, 11 tab 1,
14, 16B, 27 A through J,
40 tabs 1, 2, 3, 5,
40-1, 41, 40D, 40E