National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation Log 2148

Date: January 8, 1990
In reply refer to: A-89-140 through -142

Honorable James B. Busey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

Accident statistics of the National Transportation Safety Board indicate that carburetor icing continues to be a significant factor in general aviation accidents. As a result, the Safety Board examined potential measures that could be taken to alleviate the role of carburetor icing in general aviation accidents. After consulting with representatives of the General Aviation Manufacturers Association (GAMA) and the Aircraft Owners and Pilots Association (AOPA), the Safety Board has identified positive, preventive action that the Federal Aviation Administration (FAA) and GAMA should take to greatly reduce accidents related to carburetor ice.

From 1964 to 1987, the Safety Board has recorded at least 1,273 general aviation accidents in which carburetor ice was cited as a cause or factor. Of these accidents, 70 were fatal--resulting in 117 fatalities and 184 serious injuries. Additionally, there have been numerous accidents in which the probable cause could not be determined but potentially could have been related to carburetor ice.

A review of the accident statistics during the period 1976-1987 indicates 337 accidents in which carburetor ice was a factor; 23 of these accidents were fatal, resulting in 23 fatalities. Although the number of carburetor icing accidents has decreased from 1976 to present compared to the previous 12-year period, the Safety Board believes that the statistics still indicate a need for increased preventive measures and pilot education concerning carburetor icing.

The National Transportation Safety Board conducted a special study of the carburetor icing phenomenon in 1971-72.1/ The study concluded, in effect, that carburetor icing accidents continued to occur, that further pilot education was necessary, and that an advisory circular pertinent to carburetor icing should be made available to all pilots. Two safety recommendations were made to the FAA:

1/"Special Study--Carburetor Ice in General Aviation," NTSB-AAS-72-1, January 19, 1972.

A-72-40

Prepare an Advisory Circular on the prevention of carburetor icing in reciprocating engines used on general aviation aircraft.

A-72-41

Mail this publication to all general aviation pilots, flight instructors, and flight schools.

The FAA satisfied these safety recommendations by preparing and distributing Advisory Circular 60-9 in 1973.

A series of tests were conducted in 1982-83 at the FAA Technical Center to investigate carburetor ice and its effect on engine performance,2/ and the effectiveness of carburetor ice detectors.3/ One of the observations made during the tests was that the rate of carburetor ice accumulation varies with engine rpm and ambient conditions. It was noted that carburetor ice/frost could form with little moisture present in ambient air and, in some instances, ice accumulation was observed within 30 seconds at low engine rpm.

Actual engine operation under carburetor icing conditions to define engine limitations is not a requirement imposed on the engine manufacturers by the Federal Aviation Regulations (FAR), although the engine manufacturers are required to design and construct air and fuel intake passages in the engine to minimize the danger of ice accretion (FAR 33.35(b)). According to FAR 23.1093, aircraft manufacturers are required to provide a means of increasing carburetor air temperature by 90 ^{o}F. Carburetor icing is a problem, therefore, that must be scrutinized on an individual aircraft model installation.

One of the prime reasons for the persistence of accidents caused by carburetor ice is the unpredictable nature of the phenomenon, and the difficulty or inability of the pilot to detect it. Further, there are documented cases of pilots who did detect carburetor ice, but too late to avoid loss of engine power.

2/"Engine Performance Comparison Associated with Carburetor Icing During Aviation Grade Fuel and Automotive Grade Fuel Operation," DOT/FAA/CT-82/110, May 1983.

3/"Light Aircraft Piston Engine Carburetor Ice Detector/Warning Device Sensitivity/Effectiveness," DOT/FAA/CT-82/44, June 1982.

A typical accident of this type occurred on May 5, 1980, when a Piper Cherokee PA-28-151, N43954, lost engine power while on final approach to the Front Royal, Virginia Airport.4/ The pilot was unable to obtain sufficient power from the engine, and the airplane collided with power lines 1/2 mile short of the runway. The pilot suffered a broken back, and the airplane was destroyed. Meteorological conditions at the time of the accident were, in part: sky clear, visibility 15 miles, temperature 80 °F.

The flight had departed from Richmond, Virginia, and cruised uneventfully at 6,500 feet msl toward Front Royal. On arrival in Front Royal, the pilot reduced power to descend to pattern altitude. The pilot stated after the accident that during the final approach to the runway, the engine did not respond when she attempted to increase power to maintain the desired glidepath. With the tachometer indicating 1,800 rpm, carburetor heat was applied. The pilot was unable to increase the rpm, and the airplane crashed short of the runway.

The National Transportation Safety Board determined that the probable cause of the accident was: (1) the pilot's "improper operation of powerplant controls, (2) improper operation of or failure to use anti-icing/de-icing equipment, and (3) carburetor ice." Related factors included weather conditions "conducive to carburetor/induction system icing." According to the Piper Cherokee Owners Handbook, "Carburetor heat should not be applied unless there is an indication of carburetor icing, since the use of carburetor heat causes a reduction of power which may be critical in case of a go-around. Full throttle operation with heat on is likely to cause detonation." The pilot stated that she had no indication of carburetor ice until she attempted to increase power.

Safety Board investigators have examined the descent and before-landing checklists contained in the manuals and handbooks of many popular general aviation airplanes, and found a wide disparity among airplane manufacturers regarding procedures for the use of carburetor heat. Many checklists do not require the use of carburetor heat "unless icing conditions prevail" or "are suspected." Some recommend using carburetor heat "as required." Other checklists advise the pilot not to use carburetor heat "unless there is an indication of carburetor icing" or "carburetor icing conditions are known to exist." Still others require carburetor heat to be applied "when power is reduced for descent or landing," or "before closing the throttle."

Advisory Circular 60-9 has been superseded twice since its publication. The most recent advisory circular concerning engine induction system icing is AC 20-113, "Pilot Precautions and Procedures to be taken in Preventing Aircraft Reciprocating Engine Induction System and Fuel System Icing Problems," dated October 22, 1981. Page 4 of AC 20-113 states, in part, that "strict adherence to operating instructions involving the use of carburetor

4/ NTSB Brief No. 3-0679 (attached).

heat should be adhered to at all times when operating under atmospheric conditions conducive to icing." Page 4 also states: "The effects and recommendations described in this circular are general in nature and appropriate to most certificated airplanes. The pilot should refer to all available operating instructions and placards pertaining to his airplane to determine whether any special consideration or procedures apply to its operation."

Most publications advise pilots that carburetor ice can be detected by a drop in engine rpm for airplanes with fixed-pitch propellers, or a drop in manifold pressure for airplanes with a constant speed propeller. Although the use of this method of detecting carburetor ice might be practical for the steady state conditions of normal cruise flight, the method sometimes becomes less practical during descent. Experience has indicated that the distractions to a pilot during descent to enter a traffic pattern, which include preoccupation with traffic awareness and radio communications, can preclude the pilot's detection of a drop in engine rpm. Additionally, the aural detection of carburetor ice indicated by a change in engine sound is not as easily recognized as during the stabilized conditions of cruise flight.

Accordingly, the Safety Board believes that pilots need more definitive guidance from airplane manufacturers concerning the use of carburetor heat on the descent and/or before-landing checklists. Descents in most carburetor-equipped general aviation airplanes can be conducted without adverse consequences to the powerplant with full carburetor heat on when power is reduced below the normal cruise flight engine power setting (that is, below the green arc on the tachometer or the manifold pressure gauge).5/ The use of this procedure would preclude the formation of carburetor ice when detection of such formation could be difficult, in lieu of more specific guidance or procedures from manufacturers concerning designated airplane models.

Additionally, the Safety Board believes that the FAA's educational programs, such as its Accident Prevention Program and Flight Instructor refresher clinics, should include a reference to this procedure. To increase the effectiveness of this "education package," the most recent advisory circular concerning carburetor icing, AC 20-113, should be revised to reflect this procedure and distributed to all certificated pilots.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

> Amend, as necessary, in conjunction with the General Aviation Manufacturers Association and the airframe manufacturers, the descent and before-landing checklists

5/The testing conducted at the FAA Technical Center indicated instances in which engine power settings of 1,600-1,900 rpm resulted in the highest rates of carburetor ice accretion.

in the pilot's operating handbooks and airplane flight manuals of carburetor-equipped airplanes to require the use of full carburetor heat when engine power is reduced below the normal cruise power range (the green arc on the tachometer or the manifold pressure gauge), or below an alternate engine power setting as determined by the manufacturer. (Class II, Priority Action) (A-89-140)

Emphasize, through its pilot education programs, the potential problem of carburetor icing and steps to preclude its occurrence during the descent phase of flight as outlined in Safety Recommendation A-89-140. (Class II, Priority Action)(A-89-141)

Revise, as necessary, and distribute Advisory Circular 20-113 on engine induction system icing to all certificated pilots, flight instructors, and flight schools. (Class II, Priority Action)(A-89-142)

KOLSTAD, Acting Chairman, BURNETT, LAUBER, and DICKINSON, Members, concurred in these recommendations.

By: James L. Kolstad
Acting Chairman

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D. C. 20594

BRIEF OF AVIATION ACCIDENT

FILE	DATE	LOCATION	AIRCRAFT DATA	INJURIES F S M/N	FLIGHT PURPOSE	PILOT DATA
3-0679	80/5/5	FRONT ROYAL,VA	PIPER PA-28	CR- 0 1 0	NONCOMMERCIAL	PRIVATE, AGE 28, 248
	TIME - 1000		N43954	PX- 0 0 0	PLEASURE/PERSONAL TRANSP	TOTAL HOURS, 50 IN TYPE,
			DAMAGE-DESTROYED	OT- 0 0 0		INSTRUMENT RATED,

NAME OF AIRPORT - FRONT ROYAL

DEPARTURE POINT
RICHMOND,VA

INTENDED DESTINATION
FRONT ROYAL,VA

TYPE OF ACCIDENT
ENGINE FAILURE OR MALFUNCTION
COLLIDED WITH: TREES

PHASE OF OPERATION
IN FLIGHT: DESCENDING
LANDING: FINAL APPROACH

PROBABLE CAUSE(S)
PILOT IN COMMAND - IMPROPER OPERATION OF POWERPLANT & POWERPLANT CONTROLS
MISCELLANEOUS ACTS,CONDITIONS - ANTI-ICING/DEICING EQUIPMENT-IMPROPER OPERATION OF/OR FAILED TO USE
MISCELLANEOUS ACTS,CONDITIONS - ICE-CARBURETOR

FACTOR(S)
WEATHER - CONDITIONS CONDUCIVE TO CARB./INDUCTION SYSTEM ICING

PARTIAL POWER LOSS - PARTIAL LOSS OF POWER - 1 ENGINE

WEATHER BRIEFING - UNKNOWN/NOT REPORTED

WEATHER FORECAST - UNKNOWN/NOT REPORTED

EMERGENCY CIRCUMSTANCES - FORCED LANDING OFF AIRPORT ON LAND

SKY CONDITION
CLEAR

CEILING AT ACCIDENT SITE
UNLIMITED

VISIBILITY AT ACCIDENT SITE
5 OR OVER(UNLIMITED)

PRECIPITATION AT ACCIDENT SITE
NONE

OBSTRUCTIONS TO VISION AT ACCIDENT SITE
NONE

TEMPERATURE F
80

WIND DIRECTION-DEGREES
270

WIND VELOCITY-KNOTS
5

TYPE OF WEATHER CONDITIONS
VFR

TYPE OF FLIGHT PLAN
VFR