PILOT'S OPERATING HANDBOOK AND FAA APPROVED AIRPLANE FLIGHT MANUAL

SUPPLEMENT NO. 22 FOR TKS ICE PROTECTION SYSTEM (NON-FIKI INSTALLATION)

This supplement must be attached to the Pilot's Operating Handbook and FAA Approved Airplane Flight Manual when the optional TKS Ice Protection System (Non-FIKI Installation) is installed per the Equipment List. The information contained herein supplements or supersedes the basic Pilot's Operating Handbook and FAA Approved Airplane Flight Manual only in those areas listed herein. For limitations, procedures and performance information not contained in this supplement, consult the Pilot's Operating Handbook and FAA Approved Airplane Flight Manual.

FAA APPROVED: 

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SECTION 1 - GENERAL

This supplement supplies information necessary for the operation of the airplane when the TKS Ice Protection System is installed in accordance with FAA approved Piper data.

WARNING

This system is not approved for Flight Into Known Icing (FIKI) conditions.

WARNING

No determination has been made as to the capability of this system to remove or prevent ice accumulation.

CAUTION

If ice accretions are permitted to form with the ice protection system off, the surface fluid anti-ice system may not remove significant accumulations of ice. The system must be turned on immediately upon detecting ice.

NOTE

During examination of this document, the pilot is advised to identify the ice protection controls.

SECTION 2 - LIMITATIONS

There is no change to the basic airplane limitations when the TKS Ice Protection System is installed.

INTENTIONAL FLIGHT INTO KNOWN ICING IS PROHIBITED

Ice Protection Fluid

CAUTION

Under no circumstances are fluids other than those listed below to be used in the TKS system. Some fluids currently used for ground de-icing purposes contain thickening agents which may block the porous panels. If it is known or suspected that such a fluid has been placed in the tank, do not operate the system.

Ice protection fluid must meet one of the following specifications:

a. TKS 80
b. AL-5 (DTD 406B)
c. TKS R328

Fluids conforming to these specifications may be mixed in the aircraft tank in any proportions.

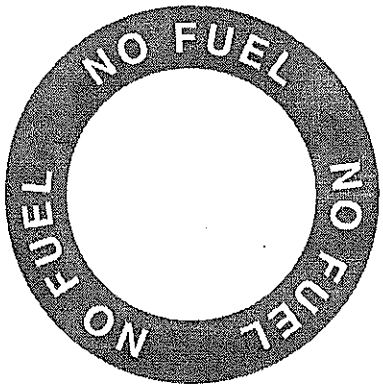
SECTION 2 - LIMITATIONS (continued)

Placards

Placard specifying fluid to be attached adjacent to the de-icing fluid tank filler cap:

T.K.S. ICE PROTECTION TANK
USE ONLY THE FOLLOWING FLUIDS
TKS 80; AL-5(DTD 406B); TKS R328

Fuel caution placard to be attached around the TKS fluid tank filler:



Placard to be fitted adjacent to porous panels:

T.K.S. ICE PROTECTION
CAUTION
POROUS DE-ICING PANELS MAY
BE DAMAGED BY CERTAIN SOLVENTS.
REFER TO SECTION 8 OF
T.K.S. SUPPLEMENT TO
PILOT'S OPERATING HANDBOOK

SECTION 2 - LIMITATIONS (continued)

Placards (continued)

Placard prohibiting flight into known icing conditions fitted on the upper control panel in front of the pilot:

FLIGHT INTO KNOWN ICING CONDITIONS
IS PROHIBITED

SECTION 3 - EMERGENCY PROCEDURES

In Flight

If unexpected icing conditions are encountered, the following procedure is recommended:

Exit the icing condition.

If exiting the icing condition is not possible, then proceed with the following:

a. Normal (NORM) Mode

Pilot workload and loss of aircraft performance due to icing are both minimized if the ice protection equipment is operated continuously during unexpected icing encounters. For this mode of operation, select the NORM position on the airframe/propeller switch when icing conditions are encountered. Select OFF when the icing conditions cease.

b. Maximum (MAX) Mode

Economy of fluid usage may be achieved by using the NORM position of the airframe/propeller switch. To remove ice which has been accreted, select the MAX position on the airframe/propeller switch until accreted ice is cleared, then select OFF or NORM, as required.

CAUTION

If ice accretions are permitted to form with the ice protection system off, the surface fluid anti-ice system may not remove significant accumulations of ice. The system must be turned on immediately upon detecting ice.

CAUTION

Aircraft stall speed and performance will change with ice accumulation on the unprotected surfaces of the aircraft. Simulated ice accumulations have produced stall speed increases of 5 knots for all configurations, a loss of 15 - 20 knots cruise speed, and a loss of 100 feet per minute of climb performance.

Stall warning indications should not be relied upon during or following icing conditions, as operation of the wing mounted sensors is likely to be impaired.

SECTION 3 - EMERGENCY PROCEDURES (continued)

In Flight (continued)

Exit the icing condition (continued).

NOTE

Loss of flow to the airframe and propeller may occur due to air entering the pump in turbulent conditions with low tank contents.

NOTE

In the event of loss of flow to the airframe and propeller with NORM selected, normal flow may be restored by selecting MAX. This procedure will not be effective if the failure is due to the de-icing pump motor or due to failure of the electrical supply to the pump.

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SECTION 3 - EMERGENCY PROCEDURES (continued)

Inadvertent Icing Encounter

CAUTION

Flight into known icing conditions is prohibited.

If icing is inadvertently encountered:

NOTE

Accumulation of fluid mist from the propeller may obstruct vision through the windshield.

NOTE

Loss of flow to the airframe and propeller may occur due to air entering the pump in turbulent conditions with low tank contents.

Pitot Heat.....ON
Windshield Defrost .....ON
Alternate Air .....OPEN

Immediately exit icing conditions.

TKS System .....Select NORM

NOTE

If ice has already been accreted, select the MAX position until accreted ice is clear, then select NORM.

NOTE

Loss of flow to the airframe and propeller may occur due to air entering the pump in turbulent conditions with low tank contents.

NOTE

In the event of loss of flow to the airframe and propeller with NORM selected, normal flow may be restored by selecting MAX. This procedure will not be effective if the failure is due to the de-icing pump motor or due to failure of the electrical supply to the pump.

SECTION 3 - EMERGENCY PROCEDURES (continued)

Descent / Landing

Select system as required.

NOTE

Accumulation of fluid mist from the propeller may obstruct vision through the windshield.

Final Approach

If icing conditions have been encountered or are anticipated:

Maximum Flap Deflection .....Approach setting or less recommended when aircraft has encountered icing conditions

Landing Distance (Approach Flaps) .....Increase full flap landing distance by 20%

Airspeed (Approach Flaps) .....Full flap approach speed +4 KIAS

CAUTION

The amount of the performance and stall degradation due to ice accumulation cannot be accurately predicted. The pilot must use extreme caution during approach and landing, being alert to the first signs of pre-stall buffet and an impending stall.

SECTION 4 - NORMAL PROCEDURES

Preflight Inspection

Battery Switch .....ON
Fluid Quantity Indicator.....Check quantity (See Limitations for weight and balance)
TKS System .....MAX
Airframe Inspection
Fluid Tank .....Check quantity - Check cap secure
Porous Panels.....Check condition and security - Check evidence of fluid from all panels and propeller
TKS System .....OFF

In Flight

FLIGHT INTO KNOWN ICING CONDITIONS IS PROHIBITED.

Descent/Landing

Select system as required.

After Landing

TKS System .....OFF

SECTION 5 - PERFORMANCE

No change from the basic airplane, with the exception of a possible 35 FPM decrease in Balked Landing Climb Performance with TKS panels installed.

SECTION 6 - WEIGHT AND BALANCE

The fluid density is 9.2 pounds per U. S. gallon.

There are no changes in the weight and balance limits with the system fitted.

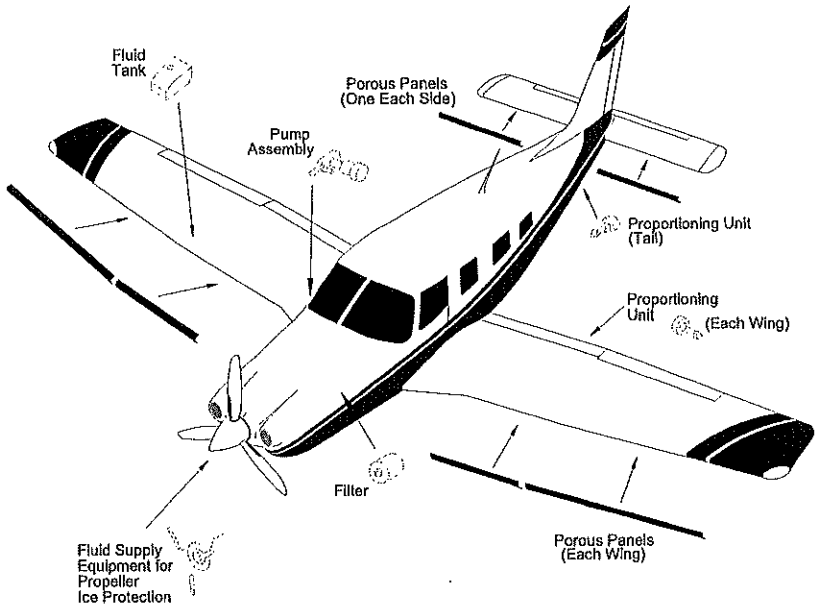
The contents indicator provides an estimate of the quantity of fluid on board. For the purposes of weight and balance, determine the true weight of fluid from the table below.

Gauge Reading	Volume (gal)	Weight (lb)	Arm (in)	Moment (in-lb)
1/4	1.125	10.4	91.4	946
1/2	2.25	20.7	91.4	1892
3/4	3.325	31.1	91.4	2838
F	4.25	39.1	91.4	3574

Ice Protection Fluid Weight and Balance
(aircraft in level attitude on ground)
Table 1

SECTION 7 - DESCRIPTION AND OPERATION

Ice protection with a TKS system is achieved by mounting laser drilled titanium panels to the leading edges of the wings and horizontal stabilizer. The propeller is protected with a fluid slinger ring.

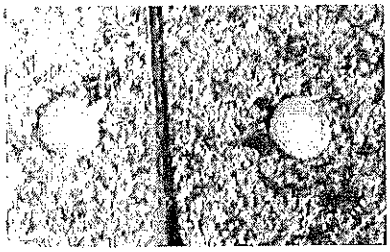


PA-32 General Location of TKS Equipment
Figure 7-1

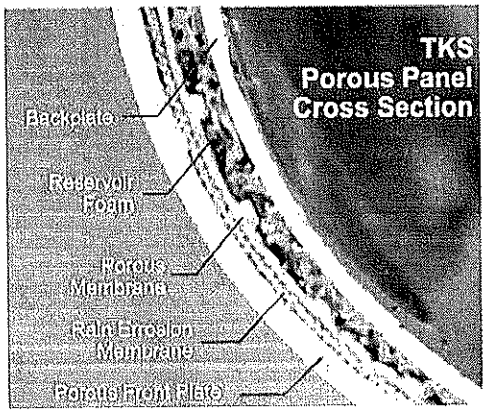
The outer skin of the ice protection panels are manufactured with 0.9 mm thick titanium. Titanium provides excellent strength, durability, light weight, and corrosion resistance. The panel skin is perforated by laser drilling holes, 0.0025 inches in diameter, 800 per square inch. The porous area of the titanium panels is designed for fluid coverage from best rate of climb speed to maximum operational speed.

The back plate of a typical panel is manufactured titanium. It is formed to create a reservoir for the ice protection fluid, allowing fluid supply to the entire porous area. A porous membrane between the outer skin and the reservoir assure even flow and distribution through the entire porous area of the panel.

SECTION 7 - DESCRIPTION AND OPERATION (continued)



Magnified View of Holes Laser Drilled Through Titanium
Figure 7-2



TKS Porous Panel Cross Section
Figure 7-3

SECTION 7 - DESCRIPTION AND OPERATION (continued)

The porous panels are bonded to the leading edges of the protected surfaces with a two-part adhesive. Porous panels cover a majority of the leading edges of the wings. Likewise, the horizontal stabilizer is completely protected with porous panels.

Fluid is supplied to the panels and propeller by a positive displacement, constant volume metering pump. The two-speed pump provides two flow rates to the panels and propeller. The low speed (NORM) supplies fluid for anti-icing during a typical icing condition. Economy of fluid usage may be achieved by using the NORM position of the airframe/propeller switch. The high speed (MAX) doubles the flow rate for removing accumulated ice or providing ice protection for more severe conditions.

NOTE

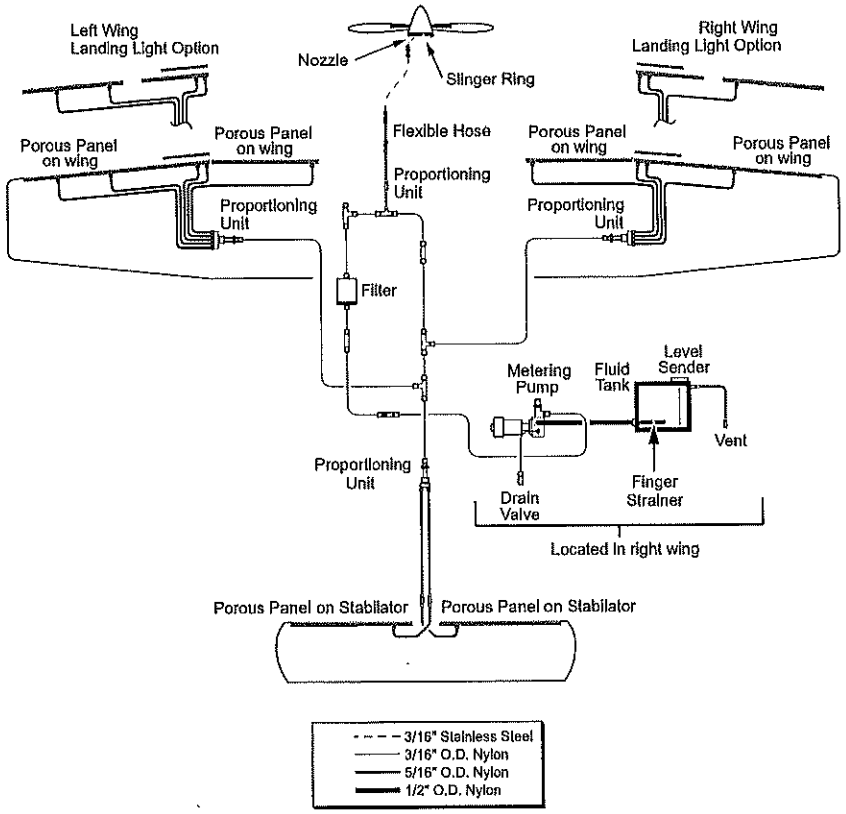
Pilot workload and loss of aircraft performance due to icing are both minimized if the ice protection equipment is operated continuously during unexpected icing encounters.

The fluid passes through a microfilter prior to distribution to the porous panels and propeller. The filter assures all contaminants are removed from the fluid and prevents panel blockage.

A system of nylon tubing carries the fluid to proportioning units typically located in the wings and tail of the aircraft. The proportioning units divide the flow into the volumetric requirements of each panel or device supplied through the unit.

This tank is serviced through a single filler located on the right (starboard) wing, outboard of the fuel filler cap. The tank has a capacity of 4.25 gallons. It is the pilot's responsibility to ensure that an adequate quantity of fluid is carried. A minimum indication of 1/4 tank is required before takeoff if the system is to be considered operational. Fluid quantity is measured by a sensor which transmits an electrical signal to the fluid indicator gauge.

SECTION 7 - DESCRIPTION AND OPERATION (continued)

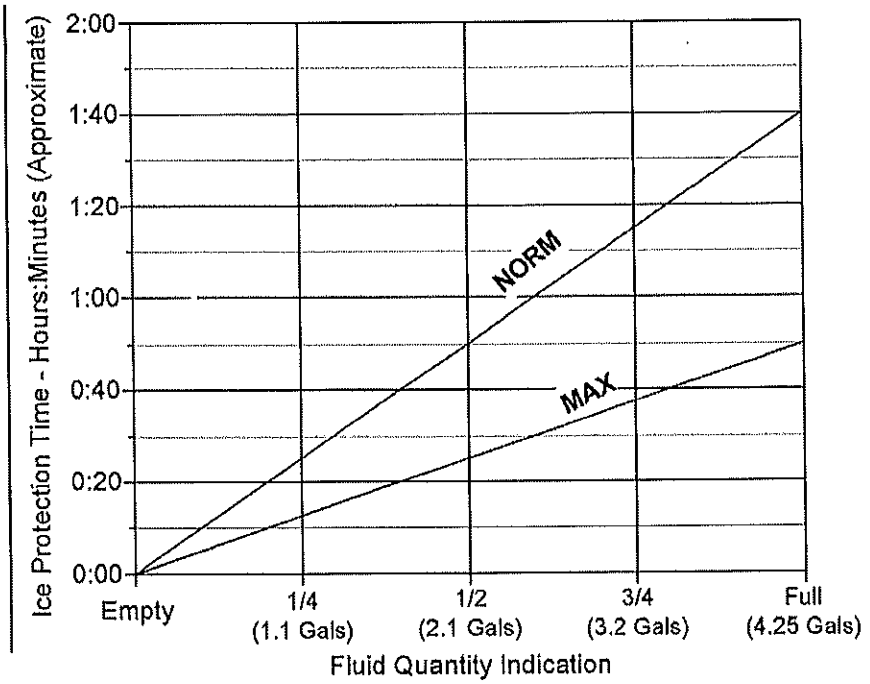


PA-32 TKS System Fluid Schematic
Figure 7-4

Maximum Fluid Endurance:

NORM selected .....approximately 1 hour and 40 minutes
MAX selected.....approximately 50 minutes

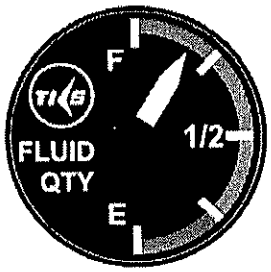
SECTION 7 - DESCRIPTION AND OPERATION (continued)



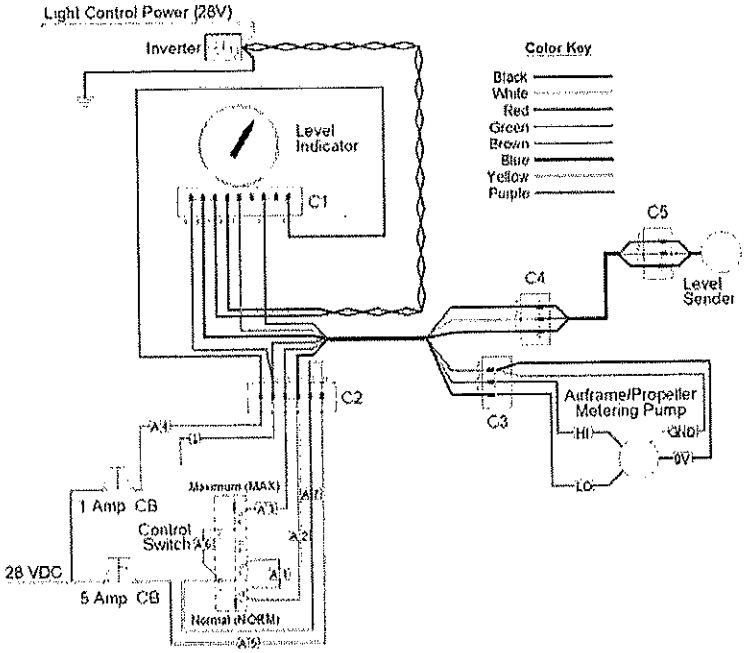
PA-32 TKS System Fluid Endurance (Quantity vs. Time)
Figure 7-5

SECTION 7 - DESCRIPTION AND OPERATION (continued)

The Contents Indicator Gauge is an analog gauge, located on the instrument panel just below the switch panel. This display dims for night operation.



Contents Indicator Gauge
Figure 7-6



System Electrical Schematic
Figure 7-7

SECTION 7 - DESCRIPTION AND OPERATION (continued)

Fluid pressure for airframe/propeller ice protection is provided by a two-speed electrically driven pump. The low speed provides the required flow when NORM is selected, and the high speed provides the required flow when MAX is selected.

The system is operated with a three-position switch, located on the instrument panel. The center position is the OFF position, deactivating the TKS system. The top position (activated by pressing in the top of the switch) activates the MAX or maximum flow rate of the system. Depressing the bottom of the switch activates the NORM or normal flow rate of the system.

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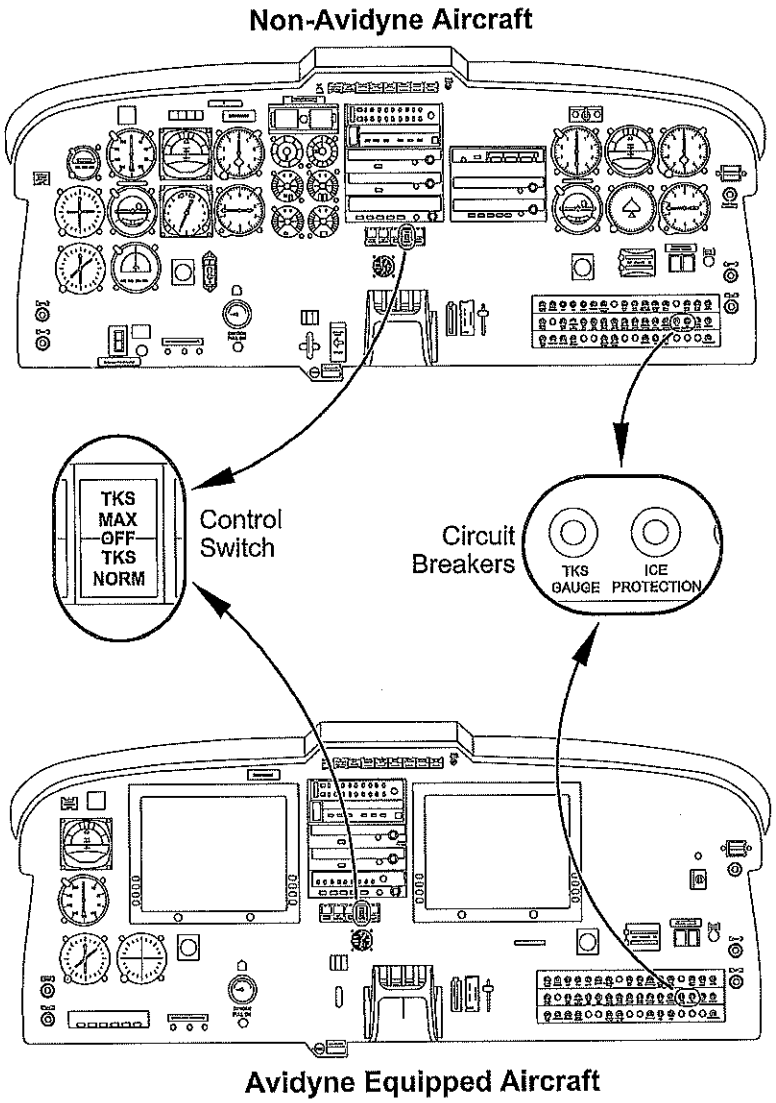
SECTION 7 - DESCRIPTION AND OPERATION (continued)



TKS System Electrical Controls
Figure 7-8

SECTION 7 - DESCRIPTION AND OPERATION (continued)

Inactive TKS System

A common occurrence with all TKS porous ice protection panels is "leaking" when not in use. Specifically, panels will stream very small quantities in flight or drip while parked. This is a normal characteristic of the TKS system because of the porous panel design.

Every panel contains a reservoir for fluid and a porous membrane. The reservoir and membrane work together to provide an even distribution of fluid over the entire porous area of the panel. The membrane is the key element, but it would not work properly unless fluid is supplied and distributed evenly to the membrane. The reservoir provides that supply.

The porosity of the membrane is designed and tuned to create a 3 psi pressure drop when ice protection fluid is forced through it. For general aviation class aircraft, the 3 psi value is far higher than any aerodynamic pressures encountered on the aircraft leading edges. The 3 psi mark assures that a uniform distribution of fluid will pass through the porous panel regardless of airspeed and air flow (angle of attack) angle.

The reservoir also assures that, when properly prepared, a relatively instantaneous supply of fluid is available at the panels for delivery. The combination of the membrane and reservoir are designed to retain the internal fluid volume as long as possible so start up time is kept to a minimum. The panel is able to retain the fluid when the fluid viscosity is maintained at a 32°F value or colder.

As the temperature of the fluid warms beyond 32°F, the viscosity drops. As an example, the viscosity of ice protection fluid at 70°F has roughly 1/3 the viscosity of 32°F fluid. With much thinner fluid, the membrane cannot resist and fluid will start to pass through the membrane.

This characteristic will be seen on the lower edge of the drilled active area of a panel, typically near the inboard end of the panel. The wing dihedral creates a small pressure head in the panel, the highest value being at this point. Fluid will slowly flow downhill in the panel reservoir, then weep from the lowest point.

Item No.	Item	Mark if Option Installed	Weight (Pounds)	Arm (In.) Aft Datum	Moment (Lbs.-In.)
	(j) Miscellaneous (Optional equipment)				
189	Inadvertent icing protection installation (TKS), Piper drawing 105401-002 and 105402-007, Avidyne Entegra system only, (Marketing option 300)				
	a.) Inadvertent icing protection system installation (TKS), (no TKS fluid included), Piper drawing 105401-002				
	1.) Aerospace Systems and Technologies wing components kit, Piper drawing 105401-002, Piper PS10107-1, Piper code number 652-563	☒	7.12	99.48	708.66
	2.) Aerospace Systems and Technologies wing panel kit, Piper drawing 105401-002, Piper PS10107-2, Piper code number 652-564	☒	11.59	80.87	937.53
	3.) Aerospace Systems and Technologies stabilator components kit, Piper drawing 105401-002, Piper PS10107-4, Piper code number 652-566	☒	4.78	280.01	1339.05
	4.) Aerospace Systems and Technologies fuselage components kit, Piper drawing 105401-002, Piper PS10107-5, Piper code number 652-567	☒	1.83	62.62	114.81
	5.) Aerospace Systems and Technologies engine compartment components kit, Piper drawing 105401-002, Piper PS10107-6, Piper code number 652-568	☒	1.11	24.28	26.85
	6.) Aerospace Systems and Technologies placards kit, Piper drawing 105401-002, Piper PS10107-9, Piper code number 652-571	☒	0.011	113.11	1.22
	7.) Aerospace Systems and Technologies fuselage-aft components kit, Piper drawing 105401-002, Piper PS10107-10, Piper code number 652-613	☒	0.49	212.35	103.42
	8.) Aerospace Systems and Technologies wing hang components kit, Piper drawing 105401-002, Piper PS10107-11, Piper code number 652-614	☒	0.33	142.96	47.69
	9.) Aerospace Systems and Technologies propeller ice protection kit (delta weight), Aerospace Systems and Technologies part number 7931-12751-38, Piper drawing 105401-002, Piper PS50077-111, Piper code number 551-054	☒	1.49	-11.63	-17.36
	10.) Brackets and hardware installation delta weight, Piper drawing 105401-002	☒	4.24	65.21	276.19
	b.) Inadvertent icing protection electrical installation (TKS), Piper drawing 105402-007				
	1.) Aerospace Systems and Technologies electrical components kit, Piper drawing 105402-007, Piper PS10107-8, Piper code number 652-570	☒	0.26	66.58	17.21
	2.) Harnesses and hardware installation, Piper drawing 105402-007	☒	0.90	92.39	83.49
	Inadvertent icing protection installation (TKS) weight		34.16	106.52	3638.74
191	Stainless steel fasteners installation, Piper drawing 101015-005				
	a.) Stainless steel fasteners installation, Piper drawing 101015-005	☒	0.376	21.99	8.26
	Removed standard fastener installation, Piper drawing 100927-022		-0.353	21.76	-7.67
	Delta stainless steel installation weight		Negligible		
	END FACTORY INSTALLED OPTIONS				
	TOTAL OPTIONAL EQUIPMENT		**127.3**	**119.3574**	**15194.2**
	END OF ORIGINAL EQUIPMENT INSTALLATION				

Item No.	Item	Mark if Option Installed	Weight (Pounds)	Arm (In.) Aft Datum	Moment (Lbs.-In.)
	(j) Miscellaneous (Optional equipment)				
185	Fixed oxygen system installation, Piper drawing 100946-002, (Marketing option 375)				
	a.) Cylinder and regulator assembly (50.1 cubic feet (charged)), Avox system part number SAC 895-24050(S), Piper code number 651-679	☒	13.52	211.16	2854.94
	b.) Fixed oxygen system kit installation and hardware, Avox systems part number SAC 802889-08, Piper drawings 36964-008 and 100946-002, Piper code number 651-679	☒	14.82	160.97	2386.27
	Fixed oxygen system installation weight		28.34	184.91	5241.21
187	Inadvertent icing protection installation (TKS), Piper drawing 105401-002 and 105402-006, (non -Avidyne Entegra), (Marketing option 300)				
	a.) Inadvertent icing protection system installation (TKS), (no TKS fluid included), Piper drawing 105401-002				
	1.) Aerospace Systems and Technologies wing components kit, Piper drawing 105401-002, Piper PS10107-1, Piper code number 652-563	☐	7.12	99.48	708.66
	2.) Aerospace Systems and Technologies wing panel kit, Piper drawing 105401-002, Piper PS10107-2, Piper code number 652-564	☐	11.59	80.87	937.53
	3.) Aerospace Systems and Technologies stabilator components kit, Piper drawing 105401-002, Piper PS10107-4, Piper code number 652-566	☐	4.78	280.01	1339.05
	4.) Aerospace Systems and Technologies fuselage components kit, Piper drawing 105401-002, Piper PS10107-5, Piper code number 652-567	☐	1.83	62.62	114.81
	5.) Aerospace Systems and Technologies engine compartment components kit, Piper drawing 105401-002, Piper PS10107-6, Piper code number 652-568	☐	1.11	24.28	26.85
	6.) Aerospace Systems and Technologies placards kit, Piper drawing 105401-002, Piper PS10107-9, Piper code number 652-571	☐	0.011	113.11	1.22
	7.) Aerospace Systems and Technologies fuselage-aft components kit , Piper drawing 105401-002, Piper PS10107-10, Piper code number 652-613	☐	0.49	212.35	103.42
	8.) Aerospace Systems and Technologies wing hang components kit, Piper drawing 105401-002, Piper PS10107-11, Piper code number 652-614	☐	0.33	142.96	47.69
	9.) Aerospace Systems and Technologies propeller ice protection kit (delta weight), Aerospace Systems and Technologies part number 7931-12751-38, Piper PS50077-111, Piper code number 551-054	☐	1.49	-11.63	-17.36
	10.) Brackets and hardware installation delta weight, Piper drawing 105401-002	☐	4.24	65.21	276.19
	b.) Inadvertent icing protection electrical installation (TKS), Piper drawing 105402-006				
	1.) Aerospace Systems and Technologies electrical components kit, Piper drawing 105402-006, Piper PS10107-8, Piper code number 652-570	☐	0.26	66.58	17.21
	2.) Harnesses and hardware installation, Piper drawing 105402-006	☐	0.90	92.39	83.49
	Inadvertent icing protection installation (TKS) weight		34.16	106.52	3638.74