

**TWIN COMMANDER
AIRWORTHINESS DIRECTIVE
SMALL AIRCRAFT AND ROTORCRAFT**

98-20-34 TWIN COMMANDER AIRCRAFT CORPORATION: Amendment 39-10801; Docket No. 97-CE-57-AD.

Applicability: Models 500, -500-A, -500-B, -500-S, -500-U, -520, -560, -560-A, -560-E, -560-F, -680, -680-E, -680FL(P), -680T, -680V, -680W, -681, -685, -690, -690A, -690B, 690C, -690D, -695, -695A, -695B, and 720 airplanes (all serial numbers), certificated in any category.

NOTE 1: This AD applies to each airplane identified in the preceding applicability provision, regardless of whether it has been modified, altered, or repaired in the area subject to the requirements of this AD. For airplanes that have been modified, altered, or repaired so that the performance of the requirements of this AD is affected, the owner/operator must request approval for an alternative method of compliance in accordance with paragraph (d) of this AD. The request should include an assessment of the effect of the modification, alteration, or repair on the unsafe condition addressed by this AD; and, if the unsafe condition has not been eliminated, the request should include specific proposed actions to address it.

Compliance: Required as indicated, unless already accomplished.

To minimize the potential hazards associated with operating the airplane in severe icing conditions by providing more clearly defined procedures and limitations associated with such conditions, accomplish the following:

(a) Within 30 days after the effective date of this AD, accomplish the requirements of paragraphs (a)(1) and (a)(2) of this AD.

NOTE 2: Operators should initiate action to notify and ensure that flight crewmembers are apprised of this change.

(1) Revise the FAA-approved Airplane Flight Manual (AFM) by incorporating the following into the Limitations Section of the AFM. This may be accomplished by inserting a copy of this AD in the AFM.

"WARNING

Severe icing may result from environmental conditions outside of those for which the airplane is certificated. Flight in freezing rain, freezing drizzle, or mixed icing conditions (supercooled liquid water and ice crystals) may result in ice build-up on protected surfaces exceeding the capability of the ice protection system, or may result in ice forming aft of the protected surfaces. This ice may not be shed using the ice protection systems, and may seriously degrade the performance and controllability of the airplane.

- During flight, severe icing conditions that exceed those for which the airplane is certificated shall be determined by the following visual cues. If one or more of these visual cues exists, immediately request priority handling from Air Traffic Control to facilitate a route or an altitude change to exit the icing conditions.

- Unusually extensive ice accumulation on the airframe and windshield in areas not normally observed to collect ice.

- Accumulation of ice on the lower surface of the wing aft of the protected area.

- Accumulation of ice on the engine nacelles and propeller spinners farther aft than normally observed.

- Since the autopilot, when installed and operating, may mask tactile cues that indicate adverse changes in handling characteristics, use of the autopilot is prohibited when any of the visual cues specified above exist, or when unusual lateral trim requirements or autopilot trim warnings are encountered while the airplane is in icing conditions.

- All wing icing inspection lights must be operative prior to flight into known or forecast icing conditions at night. [NOTE: This supersedes any relief provided by the Master Minimum Equipment List (MMEL).]

(2) Revise the FAA-approved AFM by incorporating the following into the Normal Procedures Section of the AFM. This may be accomplished by inserting a copy of this AD in the AFM.

"THE FOLLOWING WEATHER CONDITIONS MAY BE CONDUCTIVE TO SEVERE IN-FLIGHT ICING:

- Visible rain at temperatures below 0 degrees Celsius ambient air temperature.
- Droplets that splash or splatter on impact at temperatures below 0 degrees Celsius ambient air temperature.

PROCEDURES FOR EXITING THE SEVERE ICING ENVIRONMENT:

These procedures are applicable to all flight phases from takeoff to landing. Monitor the ambient air temperature. While severe icing may form at temperatures as cold as -18 degrees Celsius, increased vigilance is warranted at temperatures around freezing with visible moisture present. If the visual cues specified in the Limitations Section of the AFM for identifying severe icing conditions are observed, accomplish the following:

- Immediately request priority handling from Air Traffic Control to facilitate a route or an altitude change to exit the severe icing conditions in order to avoid extended exposure to flight conditions more severe than those for which the airplane has been certificated.

- Avoid abrupt and excessive maneuvering that may exacerbate control difficulties.

- Do not engage the autopilot.

- If the autopilot is engaged, hold the control wheel firmly and disengage the autopilot.

- If an unusual roll response or uncommanded roll control movement is observed, reduce the angle-of-attack.

- Do not extend flaps when holding in icing conditions. Operation with flaps extended can result in a reduced wing angle-of-attack, with the possibility of ice forming on the upper surface further aft on the wing than normal, possibly aft of the protected area.

- If the flaps are extended, do not retract them until the airframe is clear of ice.

- Report these weather conditions to Air Traffic Control."

(b) Incorporating the AFM revisions, as required by this AD, may be performed by the owner/operator holding at least a private pilot certificate as authorized by section 43.7 of the Federal Aviation Regulations (14 CFR 43.7), and must be entered into the aircraft records showing compliance with this AD in accordance with section 43.9 of the Federal Aviation Regulations (14 CFR 43.9).

(c) Special flight permits may be issued in accordance with sections 21.197 and 21.199 of the Federal Aviation Regulations (14 CFR 21.197 and 21.199) to operate the airplane to a location where the requirements of this AD can be accomplished.

(d) An alternative method of compliance or adjustment of the compliance time that provides an equivalent level of safety may be approved by the Manager, Small Airplane Directorate, FAA, 1201 Walnut, suite 900, Kansas City, Missouri 64106. The request shall be forwarded through an appropriate FAA Maintenance Inspector, who may add comments and then send it to the Manager, Small Airplane Directorate.

NOTE 3: Information concerning the existence of approved alternative methods of compliance with this AD, if any, may be obtained from the Small Airplane Directorate.

(e) All persons affected by this directive may examine information related to this AD at the FAA, Central Region, Office of the Regional Counsel, Room 1558, 601 E. 12th Street, Kansas City, Missouri 64106.

(f) This amendment becomes effective on November 3, 1998.

FOR FURTHER INFORMATION CONTACT:

Mr. John P. Dow, Sr., Aerospace Engineer, Small Airplane Directorate, Aircraft Certification Service, 1201 Walnut, suite 900, Kansas City, Missouri 64106, telephone (816) 426-6932, facsimile (816) 426-2169.

SEVERE ICING

Icing conditions that lie outside the FAA defined icing envelope include freezing rain, freezing drizzle, mixed conditions, or conditions defined as severe. Freezing rain, freezing drizzle and mixed conditions may result in extreme ice build-up on protected surfaces, exceeding the capability of the ice protection system. Freezing rain, freezing drizzle, mixed conditions (snow and/or ice particles and liquid droplets), descent into icing clouds from above-freezing temperatures and in some cases, exposure to icing clouds within a narrow range of indicated outside air temperature close to freezing may result in ice forming beyond the protected surfaces. This ice may not be shed using the ice protection systems, and may seriously degrade performance and controllability of the airplane.

WARNING

If ice is observed forming beyond protected surfaces, or unusual lateral trim requirements or autopilot trim warnings are encountered, the pilot should:

- Leave the icing area as soon as possible.
- If flaps are extended, do not retract until airframe is clear of ice.
- Increase speed as much as configuration and weather will allow.
- If autopilot is engaged, hold controls firmly and disengage autopilot. Do not re-engage autopilot until airframe is clear of ice.

The pilot should be continuously alert to the possibility that icing conditions that lie outside the FAA defined icing envelope may produce hazardous accumulations of ice. Divert the flight immediately when such conditions are encountered. The following may be used to identify possible severe icing conditions:

- Accumulation of ice on the lower surface of the wing aft of the protected area.
- Accumulation of ice on the propeller spinner farther back aft than normally observed.
- Unusually extensive ice accreted on the airframe in areas normally not collecting ice.
- Visible rain at temperatures at or slightly below freezing.
- Droplets that splash or splatter on impact at temperatures below zero degrees centigrade

When operating in icing conditions, monitor the outside air temperature. While severe icing may form at temperatures as cold as 0° F (-18° C), increased vigilance is warranted at temperatures around freezing, with visible moisture present. Consider the preceding described means to identify possible severe icing conditions. If you are in the described conditions:

- Avoid use of the autopilot when in conditions conducive to severe icing. The autopilot may mask unusual control system forces.
- If an unusual roll response or uncommanded input is observed, reduce the angle of attack by lowering the nose and applying additional power if needed.
- Avoid excessive maneuvering, which can result in exacerbating an aileron stall condition.
- Avoid using flaps during extended operation in icing. Operation with flaps extended can result in a reduced wing angle of attack, and ice forming farther aft on the wing, possibly aft of the protected area.
- Exit the severe icing conditions as quickly as possible to avoid extended exposure to icing conditions outside those which the airplane has been certificated. Declaration of an emergency can assist in getting expeditious assistance and clearance to depart severe icing conditions and is fully justified.

ABNORMAL PROCEDURES

FLIGHT IN MODERATE TO SEVERE TURBULENCE

If moderate to severe turbulence cannot be avoided, the following procedure is recommended:

Avoid control action which could give rapid changes in attitude, altitude or airspeed; whenever possible achieve steady flight conditions prior to entry into turbulence. Flaps should be fully retracted and autopilot disengaged.

Slow to VA speed in severe turbulence, or turbulence penetration speed in moderate turbulence, keep pilot control movements to a minimum and fly a straight course through the turbulence, as far as practicable concentrating on attitude and disregarding altitude.

WARNING

Failure to slow to VA can result in structural damage or loss of airplane due to the magnitude of the gust loads or loss of control.

WARNING

DO NOT retard power levers aft of FLT IDLE stop to reduce the airplane speed. In-flight operation aft of FLT IDLE stop may result in structural damage or loss of airplane.

NOTE

Since a finite period of time is required to reduce speed from the onset of turbulence, a speed reduction should be accomplished in anticipation of suspected turbulence, whenever possible.

UNBALANCED FUEL QUANTITY

The airplane is limited to a maximum indicated fuel quantity differential between fuel tanks of 100 pounds when fuel quantity in each tank is greater than 1000 pounds, and a differential between tanks of 200 pounds when fuel quantity in each tank is less than 1000 pounds. Fuel imbalance causes a deterioration in airplane stall characteristics if the imbalance is great enough, but if fuel imbalance remains within the specified limitations, no adverse stall characteristics will be encountered.

Two methods are available to correct an unbalanced fuel condition on the ground:

- A.
 - 1. Ensure airplane is level.
 - 2. Fuel Interconnect Valve - OPEN. Fuel will flow, by gravity, from the tank with the higher fuel level until the fuel level is equal in both tanks.
 - 3. Fuel Quantity Gages - MONITOR while interconnect valve is open.
 - 4. Fuel Interconnect Valve - CLOSE when fuel quantity gages indicate unbalanced fuel condition is corrected.
- B. Service wing which indicates lower fuel quantity with enough fuel to correct unbalanced fuel condition.

To correct an unbalanced fuel condition in flight:

- 1. Fuel Interconnect Valve - OPEN. Lower wing on the low fuel side, approximately 5 degrees, while maintaining a constant heading.
- 2. Fuel Quantity Gages - MONITOR while interconnect valve is open.
- 3. Fuel Interconnect Valve - CLOSE when fuel quantity gages indicate unbalanced fuel condition is corrected, then resume normal flight attitude.

NOTE

Airplane must be in wings level attitude for accurate fuel quantity indication.

INTRODUCTION

Section IV of the Pilot's Operating Handbook contains the recommended procedures for normal operation of the airplane. The first part of this section presents the normal operating procedures in an abbreviated checklist form. The second part of this section presents amplified operating procedures.

NOTE

Refer to Section IX, Supplements, of this Pilot's Operating Handbook, for amended operating limitations, operating procedures, performance data and other necessary information for specific optional equipment installed in your airplane.

AIRSPEEDS FOR SAFE OPERATION

Conditions:	
1.	Takeoff Weight - 11,200 Pounds
2.	Landing Weight - 10,550 Pounds
3.	Sea Level, Standard Day
1.	Two Engine Climb (after takeoff) to 50 feet (0° Flaps) 102 KIAS
2.	All Engines Best Angle-Of-Climb Speed (V _X) (0° Flaps & Gear Up) 95 KIAS
3.	All Engines Best Rate-Of-Climb Speed (V _Y) (0° Flaps & Gear Up) 135 KIAS
4.	All Engines Landing Approach Speed (40° Flaps) 100 KIAS
5.	Maneuvering Speed (V _A) (11,200 lbs) 139 KIAS
6.	Moderate Turbulence Penetration Speed 180 KIAS
7.	Maximum operating speed (V _{MO}) 250 KIAS
8.	Speed for Transition To Balked Landing Conditions 105 KIAS
9.	Maximum Demonstrated Crosswind Velocity TAKEOFF 30 KTS LANDING 27 KTS
10.	Minimum Speed During Sustained Icing Conditions 145 KIAS

NORMAL PROCEDURES ABBREVIATED CHECKLIST

PREFLIGHT INSPECTION

NOTE

Remove pitot covers, engine inlet covers, engine inlet moisture drain tool and tailpipe covers before beginning pre-flight inspection.

NOTE

Visually check inspection plates and general airplane condition during exterior inspection. Ensure fuel filler caps are properly installed to prevent the possibility of fuel siphoning in flight.

FLIGHT IN ICING CONDITIONS

The airplane has been certificated for flight in known icing conditions in accordance with applicable FAA requirements, however, the FAA does not require the airplane be able to operate for an unlimited period of time in severe or extreme icing conditions. Safe operation in icing conditions is dependent on pilot knowledge regarding atmospheric conditions conducive to ice formation, familiarity with the operation and limitations of the installed equipment, and the exercise of good judgement when planning a flight into areas where possible icing conditions exist.

When possible, flight in known icing conditions should be limited to climbs and descents. Avoid operation in icing conditions during the cruise portion of the flight, whenever possible, since ice accumulations increase drag and degrade scheduled cruise performance. Operation at higher cruise altitudes, where temperature can generally be expected to be below -15°C , will minimize the effects of icing.

The airplane has been flight tested, and has demonstrated satisfactory operation, with ice accumulations of approximately two to four inches in depth on the unprotected areas of the airplane structure. This will allow for unavoidable in-flight delays due to Air Traffic Control instructions when operating in icing conditions. If ice accumulates to a depth of greater than approximately three inches on the unprotected surfaces of the airplane, the icing conditions should be considered to be severe and immediate action should be taken to alter the flight plan so as to escape the icing conditions.

When icing conditions are encountered, the recommended procedure is to change to an altitude where icing conditions are not present, particularly if it is known that the icing conditions at that particular altitude are wide spread. Ice accumulations on the airplane have the effect of:

1. Increasing aerodynamic drag.
2. Reducing airplane range.
3. Increasing stall speed.
4. Reducing climb performance.

CAUTION

Avoid large ice build-ups on the unprotected areas of the airplane when practical, particularly when a descent into warmer air is anticipated which will cause rapid shedding of the accumulated ice. Large chunks of ice shedding off the unprotected areas may result in minor structural damage to the leading edge of the horizontal stabilizer.

As a general rule, ice accumulations which have the most adverse effect are those which occur at temperatures between 15°F (-10°C) and 32°F (0°C), particularly in the 25°F (-4°C) to 30°F (-1°C) range. Increased altitude and temperatures below 15°F (-10°C), will generally reduce the effects of icing.

Icing conditions may exist in any type of cloud formation when the temperature is below freezing, therefore, it is necessary to closely monitor outside air temperature when flying in clouds or precipitation. The heaviest icing found in stratus type clouds is generally associated with a well defined cloud formation. Ice will generally form more rapidly at an altitude of approximately 200 to 400 feet below the tops of such clouds.

Stall speeds increase more rapidly with the first $\frac{1}{4}$ inch of ice accumulation on the wing leading edge, and continue to increase, although less rapidly, as ice builds up to $\frac{1}{2}$ inch to $\frac{3}{4}$ inch. Stall speeds will increase as much as 27 knots with the flaps up and 12 knots with the flaps full down.

Since stall speeds increase significantly with even small accumulations of ice on the wing leading edge, abrupt maneuvering and steep turns at low airspeeds should be avoided. Maintain additional airspeed on the final landing approach to compensate for the increase in pre-stall buffet speed associated with ice accumulations on the airplane. The additional airspeed required may be as high as 12 KIAS during a normal (full flap) landing, and as high as 34 KIAS when the flaps are retracted.

CAUTION

To prevent a hard landing due to a higher than normal stall speed, use power during the roundout and touchdown when accomplishing a landing with ice accumulated on the airplane. Placing the power levers in FLT IDLE during the roundout, may result in a stall caused by the rapid bleed off of airspeed which results when power levers are placed in FLT IDLE position.

WARNING

As ice is accumulated on the wing leading edge, and the pre-stall buffet speed increases, the stall warning vane may not actuate until after the pre-stall buffet has begun. When ice has been cleared from the wing leading edge, the stall warning system should operate normally. If, however, any ice remains on the leading edge after the boots have been cycled, a reduction in the stall warning system accuracy may result due to the resulting higher pre-stall buffet speeds and to alteration of the air flow in the vicinity of the stall warning vane.

Maintain a comfortable margin of airspeed above the normal stall airspeed. In order to minimize ice accumulation on unprotected surfaces of the wing, maintain a minimum of 145 KIAS during operations in sustained icing conditions.

Prior to a landing approach, cycle the deicing boots to shed any accumulated ice.

Landing distances will increase significantly (approximately 60 percent) when landing is accomplished with heavy ice accumulations on the airplane. This increase is due to the higher than normal final approach speeds required.

Equipment Operation

NOTE

Thermo-electric anti-icing and deicing equipment must be turned on any time the temperature is below 40°F (5°C) and visible moisture is present.

1. Surface Deice Boots

NOTE

Verify that all deicer boots have been treated with ICEX within the last 50 hours.

- a. Preflight - Check wing and empennage boots for damage and cleanliness.

Two pressure switches, mounted on the compressor-condenser unit, protect the compressor and compressor motor. A high pressure switch protects the motor against excessive current draw due to system high pressure. The switch opens at 300 (± 30) psig and shuts off the motor. The switch will automatically reset after the pressure decays to 100 (± 20) psig.

A low pressure switch in the power relay control circuitry opens on decrease of system pressure resulting from a leak or low pressure due to low ambient temperatures. The switch is normally open and closes on rise of pressure. The switch opens at 20 ($+10, -5$) psig and automatically resets at 40 psig maximum.

The AIR COND/FAN switch (refer to Figure 7-24A) is a three-position switch which controls the operation of the compressor and the evaporator fans. OFF position turns the system off; AIR COND position provides power to the compressor motor and both evaporator fan motors. AC annunciator light illuminates to indicate air conditioning system is operating. FAN position provides power to the evaporator fan motors only; compressor unit is not operating and AC annunciator will be extinguished. The EVAP switches are two-position switches that control the speed of the evaporator blower fans. Placing the switches in HI provides maximum cool air outflow from the evaporators.

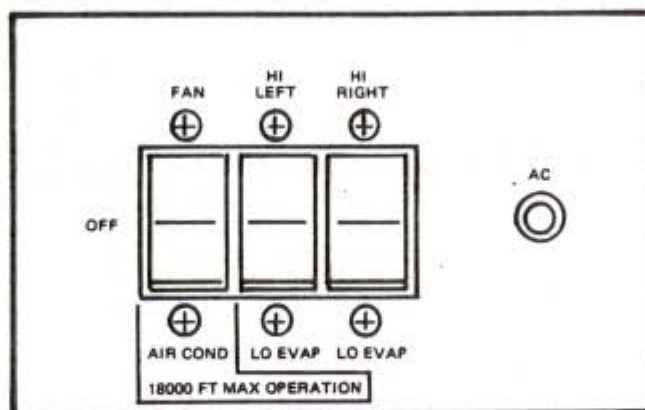


Figure 7-24A. Air Conditioning Switch Panel

ICE PROTECTION SYSTEMS

The airplane is equipped with deicing and anti-icing systems. The deicer systems include the wing and empennage deicer boots and the propeller deicer system. The function of the deicer systems is to eliminate ice after it accumulates. The anti-icing systems are designed to prevent ice accumulation and should be placed in operation prior to entering flight conditions conducive to the formation of ice. The anti-icing systems include heated stall warning, rudder horn anti-icer, rudder tab anti-icer, generator inlet anti-icer, electrically heated windshield and the pitot-static heaters. These systems utilize electrical heaters, controlled by switches located in the ICE PROTECTION group of the overhead switch panel.

The ice protection systems also include wing ice inspection lights, located in the outboard side of each engine nacelle, iceshields, located on each side of the fuselage in the propeller plane of rotation, and engine inlet heaters. The engine inlet heaters utilize hot engine compressor bleed air to prevent icing, and are controlled by switches in the ICE PROTECTION group of the overhead switch panel.

WING AND EMPENNAGE DEICER BOOTS (Figure 7-25)

Pneumatically operated boots, made from fabric reinforced rubber sheet and containing inflatable rubber tubes, are installed on the leading edge of the wing, inboard and outboard of the engine nacelles, and on the leading edge of the horizontal and vertical stabilizer. Regulated bleed air, from the airplane pneumatic system, is used to inflate the boots.

Vacuum (suction) generated by a venturi system in the distribution valve, deflates the boots and holds them tight against the wing and empennage leading edge when system is not in operation.

The BOOTS switch, in the overhead switch panel, controls the solenoid operated distribution valve. The switch is a three-position switch, spring-loaded to the OFF position. Placing the switch in the momentary ONE CYCLE position, activates the distribution valve through the timer, inflating the wing and empennage boots simultaneously, for approximately six seconds. Each activation of the ONE CYCLE position will inflate the boots for approximately six seconds. When the switch is placed in the MANUAL position, the timer is bypassed and the boots will inflate simultaneously and remain inflated until the switch is released. The MANUAL position is normally used only in the event of a timer malfunction.

The deicer boots remove ice by changing the contour of the leading edge, cracking the ice formation, and allowing the airflow to blow the broken ice away. Rapid cycling of the boots may allow an ice "bridge" to build up over the boots in such a manner that the boots are rendered ineffective. It is recommended that the boots not be activated until ice accrues on the wing leading edge to a depth of approximately $\frac{1}{2}$ to $\frac{3}{4}$ inches.

Operation of the deicer boots should be checked prior to encountering icing conditions, while on the ground or in flight, when the OAT is above -40°C (-40°F).

The boots operate on regulated air pressure from the airplane pneumatic system. If system pressure exceeds the normal operating limits due to a failure of the pneumatic system pressure regulator, a REG AIR annunciator will illuminate to indicate system pressure is too high.

CAUTION

Do not operate deicer boots if REG AIR annunciator is illuminated. Boots may be physically damaged.

The boots should be cleaned regularly with mild soap and water and then treated with B. F. Goodrich ICEx No. 6 to protect the boots and reduce ice adhesion.

PROPELLER DEICING SYSTEM

The propeller deicing system consists of boots, containing electrical heating elements, bonded to the inner and outer surface of the leading edge of each propeller blade. A slip-ring and brush block assembly on each propeller, a circuit breaker switch, an electronic timer and necessary wiring complete the system. An ice protection system indicator, located in the overhead switch panel, allows the pilot to verify system operation.

Deicing is accomplished by providing electrical power to the heating elements embedded in the boots, in a time sequence. The heat reduces the adhesion between the ice and the propeller blade, and centrifugal force and airstream blast causes the ice to be thrown off the blades. Iceshields protect both sides of the fuselage from damage due to loose ice.

Placing the PROP switch, located in the ICE PROTECTION group in the overhead switch panel, in the PROP position, activates the timer which provides 28-volt dc power to the deicer boots. The timer directs current to the propeller boots in cycles between boot elements, and between propellers, in the following sequence; right propeller outer boots, right propeller inner boots, left propeller outer boots, left propeller inner boots. Each heating sequence lasts 34 seconds and each cycle takes 2.27 minutes. The cycles will repeat as long as the PROP switch is on.

AIRPLANES S/N 96001 THRU 96049 WHICH HAVE NOT HAD SERVICE BULLETIN 194 COMPLIED WITH.

Propeller deicer heating elements draw 14 to 18 amps of power when the system is in operation. A reading below 14 amps on the deice system ammeter, indicates one or more heating elements is inoperative, which will result in uneven ice removal.

CAUTION

When uneven deicing of the propeller blades is indicated, turn deice system OFF. Uneven deicing of the propeller blades can result in propeller unbalance and engine damage.

Propeller blades are equipped with a strip of polyurethane tape on the blade leading edge, extending from the deicer boot toward the tip. The tape protects the leading edge of the blades against abrasion. The tape also improves the prop deicing capability by providing a smooth surface to which ice does not adhere as readily as it does to the bare blade.

The tape must be carefully inspected prior to each flight for any indication of surface roughness, holes, wrinkles or lifting of edges. If any of these conditions are discovered, the damaged tape must be removed and replaced prior to flight into known icing conditions. Tape that is damaged loses a significant amount of its deicing capability and may cause propeller imbalance in icing conditions.

NOTE

To prevent possible propeller imbalance, always replace tape on all three blades if the tape on a single blade requires replacement.

AIRPLANES S/N 96000 AND 96051 THRU 96200 AND THOSE AIRPLANES WHICH HAVE HAD SERVICE BULLETIN 194 COMPLIED WITH.

The current draw for the propeller deice heating element will be displayed as a reading of approximately 62.5 on the loadmeter. A reading of 60 or less, indicates a possible system malfunction which may result in uneven ice removal. An abnormally high reading (80 or more) indicates a possible deterioration in the system. If abnormal readings are observed during preflight, have the system checked before flight in icing conditions is conducted. If abnormal readings are observed in flight, monitor system operation closely and terminate flight in icing conditions as soon as possible.

CAUTION

When uneven deicing of the propeller blades is indicated, turn propeller deice system off. Uneven deicing of the propeller blades can result in propeller unbalance and engine damage.

GENERATOR INLET ANTI-ICING SYSTEM

Electrically operated generator inlet anti-icing boots provide anti-icing for the generator cooling air inlets. The anti-ice boots, installed in each upper engine nose cowl, contain an electrical heating element protected by an overheat protection relay. A temperature sensor on each boot senses the operating temperature of the heating element, and by opening and closing the overheat relay, maintains the proper operating temperature. A GEN INLET circuit breaker switch, located in the ICE PROTECTION group in the overhead switch panel, provides power to both generator inlet heaters.

CAUTION

Operating the generator air inlet anti-icing system, when ambient temperature is above 4-5°C (40°F), will damage the heating elements.

RUDDER ANTI-ICING SYSTEM

The rudder anti-icing system consists of three separate, electrically heated elements: Two heater elements are installed in the slot between the rudder overhang and the top of the vertical stabilizer. The third element is attached to the forward edge of the rudder trim tab. The two position RUDDER switch, located in the ICE PROTECTION group in the overhead switch panel, provides 28-volt dc power, through a relay, to all three elements. The trim tab heater is a neoprene material with an embedded wire heating element. The rudder slot heaters are heating elements embedded in dielectric material and coated with stainless steel cladding.

CAUTION

Operating rudder anti-icing system, when ambient temperature is above 4-5°C (40°F), will damage the heating elements.

PITOT/STATIC ANTI-ICING SYSTEM

The airplane is equipped with two separate pitot/static anti-icing systems. The left system provides anti-icing heat to the left (pilot's) pitot head and both pilot's static ports. The right system provides anti-icing heat to the right (co-pilot's) pitot head. The co-pilot's static ports are not heated.

The left system is controlled by a circuit breaker switch labeled L PITOT/STATIC, located in the ICE PROTECTION group in the overhead switch panel. Placing the switch in L PITOT/STATIC provides 28-volt dc power to electrical heater elements in the pilot's pitot head and static ports.

The right system is controlled by a circuit breaker switch labeled R PITOT, located in the ICE PROTECTION group. Placing the switch in R PITOT position provides 28-volt dc power to electrical heater elements in the right (co-pilot's) pitot head.

Power requirements will vary due to changes in ambient temperature. Power requirements are generally highest when the systems are first turned on and decrease as the heaters warm up.

STALL WARNING ANTI-ICING SYSTEM

The stall warning anti-icing system provides 28-volt dc power to electrical heaters in the stall warning vane and transducer unit located in the leading edge of the right wing. The system is controlled by a two position circuit breaker switch, located in the UTILITY group in the overhead switch panel, labeled STALL HEAT. The heaters use approximately 9.3 amps, however, power requirements vary with temperature.

Power to the stall warning heater system is controlled through the STALL HEAT switch, however, the system is wired through the R PITOT heat circuit and through the landing gear ground contact (squat) switch. The stall warning heaters will be inoperative when the R PITOT switch is off or when the airplane is on the ground and R PITOT heat is on.

The design of the transducer unit is such that operation of the stall warn heater under warm ambient air conditions will result in an excessive heat build-up in the unit causing damage to the system. The unit should be turned on only when ambient temperature is 5°C (40°F), or below.

Operation of the stall warning heat system can be verified in flight by using the following procedure:

1. Right Pitot Heat - ON.
2. Stall Warn Heat - OFF.
3. Ice Protection Indicator Selector Switch - R PITOT. Note indicator reading.
4. STALL HEAT Switch - STALL HEAT. Note indicator reading increases approximately 9 amps on airplanes equipped with an ammeter and approximately 46.5 on airplanes equipped with a loadmeter. A zero increase on the indicator indicates stall warning heater is inoperative.

WINDSHIELD ANTI-ICE SYSTEM

The windshield anti-ice system consists of a resistance wire heating element between the outer tempered glass ply and the vinyl layer in each windshield. Each heating element is controlled by a thermostat system to a maximum temperature of $107 (\pm 11)$ degrees F.

Two three-position, rocker type switches, labeled L WSHLD and R WSHLD, located in the ICE PROTECTION group in the overhead switch panel, provide 28-volt dc power to the windshield heating elements. Placing the switches in the LOW position provides 2.9 watts per sq. in. of heating power to the entire windshield heating element. The LOW position provides the maximum heated windshield area. Placing the switches in the HIGH position provides 4.5 watts per sq. in. of heating power to a segment of the windshield heating element. The HIGH position provides high heat over a reduced windshield area.

Each windshield draws approximately 28-amps when operating in HIGH. Windshield amperage is indicated on the airplane Volt-ammeters.

Use of high windshield heat will cause some visual distortion. Use low windshield heat if windshield heat is required during final approach and landing.

WARNING

Standby magnetic compass indications are completely unreliable when either windshield anti-icing system is in operation.

WING ICE INSPECTION LIGHTS

Wing ice inspection lights permit the pilot to visually check the wing leading edge at night for indications of ice accumulation. An inspection light is installed in the outboard side of each engine nacelle, focused on the wing leading edge. A switch labeled WING INSP, located in the UTILITY GROUP in the overhead switch panel, provides 28-volt dc power to the ice inspection lights.

ENGINE INLET ANTI-ICE SYSTEMS

The engine inlet anti-ice systems utilize hot engine compressor bleed air to heat the lower surface of the engine compressor air inlet. A solenoid operated anti-icing valve on each engine furnishes compressor bleed air which is circulated beneath the skin of the lower surface of the inlet to keep it free of ice. The entire upper portion of the compressor air inlet is integral with the gear box and is kept free of ice accretion by heat transfer from engine oil to the inlet surface.

Two switches, labeled ENG INLET, L and R, located in the ICE PROTECTION group, control the anti-icing valves on each engine. Placing the switches in L and R positions will open the anti-icing valves and furnish compressor bleed air for anti-icing. L INLET and R INLET annunciators, located in the annunciator panel, will illuminate when the L and R INLET switches are placed on, and a slight decrease in engine horsepower and fuel flow will be observed. The engine inlet anti-icing system should be turned on any time the OAT is $+5^{\circ}\text{C}$ (40°F), or below, and visible moisture is present.

WARNING

When icing conditions may be encountered, do not delay operation of the engine inlet heat systems. Turn the systems on before any ice accumulates. Engine inlet heat must be on if icing conditions exist or are anticipated.

SUPPLEMENT 8

COLLINS AP-106/FD 112V AUTOPILOT/FLIGHT DIRECTOR (WITH MANUAL ELECTRIC ELEVATOR TRIM)

SECTION I

GENERAL

The purpose of this Pilot's Operating Handbook Supplement is to provide the information necessary for operation of the Collins AP-106/FD-112V Autopilot/Flight Director system with a Manual Electric Elevator Trim System. The information in this supplement is FAA Approved material and must be included in the Pilot's Operating Handbook when an airplane is equipped with this system.

DESCRIPTION

The AP-106 FD112V Autopilot Flight Director is a combination of autopilot, guidance, displays and sensors.

When the autopilot is engaged, the flight control system controls the airplane and the pilot monitors the flight path by observing the information displayed on the flight director. With the autopilot disengaged, the flight director presents computed commands that enable the pilot to manually control the flight path. Whether the autopilot is engaged or disengaged, the system can perform the following functions:

- a. Maintain a preselected attitude.
- b. Maintain a barometric altitude.
- c. Maintain an indicated airspeed.
- d. Capture and maintain a desired heading.
- e. Capture and maintain a preselected radio course.
- f. Capture and maintain an ILS approach to published minimums.

The autopilot has two modes of operation: attitude mode and guidance mode. When the autopilot is engaged and no modes are selected on the mode control, autopilot is in the attitude mode. The pitch hold mode is operational when autopilot is in attitude mode and TouchControl Steering (TCS) is available. When the autopilot is engaged and a mode is selected on the mode control, the autopilot is in the guidance mode. The autopilot is coupled to the flight director and accepts steering commands from the flight director computer.

When the autopilot is engaged, an autopilot flight director computer control unit controls the autopilot primary servos which position the flight controls in response to steering commands from the computer section. In addition, the computer section controls the elevator trim servo which automatically positions the elevator trim tabs to relieve elevator control forces induced by elevator control movement. An auto-trim monitor system is incorporated which provides a visual and an aural warning to the pilot in the event of a malfunction in the elevator auto-trim system while the autopilot is engaged.

The co-pilot's turn and bank indicator includes computation circuits for the autopilot yaw damping function. The yaw damper senses yaw rate and actuates the rudder servo to stabilize the yaw axis. It also provides turn coordination. A yaw damp (YD) switch allows the pilot to engage the yaw damper without engaging the autopilot.

When the autopilot is disengaged, the elevator trim servo can position the trim tabs by use of a manually operated, double-acting, rocker type switch located in the left grip of the pilot's control wheel. To operate the trim switch, the center bar must be depressed to power the switch and the rocker moved forward to power the nose down trim circuit or aft to power the nose up trim circuit. If the autopilot is engaged, depressing the center bar automatically disengages the autopilot servos.

HEADING	The heading flag indicates a failure of the compass system. All heading display and command information is unusable. For en route operation, set the computer/control mode selector buttons to off to remove the command bars from view. For terminal operation, VOR/localizer and glideslope deviation displays are still correct.
NAV	Comes into view when lateral deviation information is unusable. V-bar pitch command, heading, attitude, and glideslope information are valid if their corresponding flags are out of view.
RAD ALT	Comes into view when optional radio altimeter malfunctions. All other information is correct. Will be in view continuously if airplane is not equipped with a radio altimeter.

SECTION II

LIMITATIONS

1. Maximum airspeed for autopilot operations: 252 KCAS (V_{mo}).
2. Pilot must remain in pilot's seat with seat belt fastened during autopilot operation.
3. Do not override autopilot to change pitch angle.
4. Do not use autopilot during takeoff or landing.
5. Do not use autopilot if electric elevator trim or any of its associated annunciators are inoperative.
6. Do not use APPR mode during VOR approach until airplane is established on inbound VOR radial.
7. Approach mode is not approved for Category II ILS operation.
8. Autopilot must be disengaged below 200 feet AGL during approach and 1000 feet AGL during cruise.

Placard - Located in OPERATING LIMITATIONS placard on overhead switch panel.

AUTOPILOT OPERATION MUST BE IN ACCORDANCE WITH APPROVED PILOT OPERATING HANDBOOK.

SECTION III

EMERGENCY PROCEDURES

Maximum Altitude Loss (during autopilot malfunction tests)

1. Cruise - 400 FT.
2. ILS Approach - 100 FT.

Autopilot Disengagement

The autopilot may be disengaged by performing one of the following:

1. TRIM & AP Release Switch (on co-pilots control wheel) - REL.
2. Autopilot Engage/Disengage Switch (on the mode control) - DIS position.
3. Manual Electric Elevator Trim Switch - ACTUATE in either direction (pitch and roll only).
4. TRIM & AP Release Switch (on pilot's control wheel) - REL.
5. A/P SERVO Switch (on overhead panel) - OFF.
6. A/P SERVO Circuit Breaker (on main circuit breaker panel) - TRIP.

The autopilot automatically disengages when one of the following occurs:

1. Autopilot power failure.
2. Gyro monitor failure.
3. Pitch or Roll Gyro rate exceeded.
4. Auto-Trim Failure.

Yaw Damp Disengagement.

The yaw damper may be disengaged by performing one of the following:

1. TRIM & AP Release Switch (on co-pilots control wheel) - REL.
2. TRIM & AP Release Switch (on pilot's control wheel) - REL.
3. A/P SERVO Switch (on overhead panel) - OFF.
4. A/P SERVO Circuit Breaker (on DC Circuit Breaker Panel) - TRIP.

In-Flight Operation

Check the annunciator display to verify that proper switching has taken place during all in-flight operation. If a lateral or vertical mode drops out, the light for that mode will immediately go out.

1. **Takeoff**
Establish climb airspeed and begin climbout to cruise altitude. With autopilot disengaged, pressing the TCS button will provide pitch sync, the command bars will command flight to the pitch attitude that existed when TCS button was released and a roll rate to satisfy the selected lateral mode.

NOTE

A lateral mode must be selected to bring the command bars into view.

2. **Climb**
With climb profile established, engage the autopilot. Make heading changes as required by departure control by moving the heading marker on the course indicator. The flight control system maneuvers the airplane in a smooth coordinated turn to the new heading. The course arrow can be set to the first VOR radial that will be flown. Adjust the course knob until the head of the course arrow is set to the desired course.

If desired, IAS hold can be selected during climbout. The flight control system maneuvers the airplane, through the elevator servo, to maintain the indicated airspeed that existed at the time IAS was selected.

NOTE

For smoothest operation, stabilize airspeed prior to engagement of the IAS hold mode.

3. **Altitude Hold**
Before reaching a desired altitude, reduce vertical speed to approximately 500 feet per minute. When desired altitude is reached, press ALT button. The flight control system commands the airplane to maintain that barometric altitude. Engaging the glideslope or pressing the TCS button automatically disengages Altitude Hold.

NOTE

The altitude controller attempts to maintain the airplane at the selected altitude by changing the airplane pitch attitude. The human pilot must adjust power settings to assure a safe airspeed.

NOTE

Power applications must be made slowly (approximately 100 SHP/second) to prevent exceeding the pitch capabilities of the autopilot. Monitor autopilot performance when airspeed is being changed rapidly and altitude hold is engaged.

4. **Heading Select/Heading Hold**
 - a. Place heading marker on desired heading.
 - b. Depress HDG button. HD annunciator will illuminate. With autopilot engaged, autopilot will turn the airplane to the desired heading and then hold that heading. Repositioning the heading marker will cause the autopilot to turn the airplane to the new heading. To complete a turn of more than 135 degrees, it is best to set the heading marker approximately 135 degrees in the direction of the desired turn. After completing about 120 degrees of the turn, reselect up to 135 additional degrees.

5. **Navigation**

NOTE

When flying inbound toward a VOR, do not set up a VOR capture problem within approximately 5 miles of the VOR. The system does not have enough time to solve the problem and stabilize on course before passing over the station.

To establish the airplane on a desired VOR radial, perform the following:

- a. Tune the navigation receiver to the desired VOR frequency.
- b. Set the course arrow to the desired VOR radial.
- c. Set the heading bug to the desired intercept heading.