2A-30-10: General Description

The Gulfstream IV uses both pneumatically and electrically powered ice and rain protection systems to provide the flight crew with a means of removing and preventing ice accumulation on the following structures and components:

- Wing Leading Edges
- Engine Cowl Inlet Leading Edges
- Cockpit Windows
- Pitot Probes
- Angle of Attack Probes
- Total Air Temperature Probe

The remainder of the airplane (including the empennage) is designed in a manner that requires no anti-icing equipment.

The ice and rain protection system is divided into the following subsystems:

- 2A-30-20: Wing Anti-Ice System
- 2A-30-30: Cowl Anti-Ice System
- 2A-30-40: Windshield Ice and Rain Protection System
- 2A-30-50: Probe Anti-Ice System

Bleed air for the wing anti-ice system is supplied by the engine bleed air manifold. The engine bleed air manifold is supplied mid-stage air from each engine's 7th stage compressor section through the 7th stage check valve. Depending on conditions, high-stage air may also be supplied by each engine's 12th stage compressor through the 12th stage air control valve (often referred to as the HP valve).

Bleed air for the cowl anti-ice system is supplied directly from the engines' 7th and/or 12th stage compressor offtakes. Each engine also has a mechanical ice shedder on the Low Pressure (LP) compressor (fan) spinner.

Electrically powered heating elements warm the cockpit windows to prevent fogging and ice formation. Precipitation removal from the forward cockpit windows is provided by a pair of electrically operated windshield wipers.

Electrically powered heating elements also warm the pitot probes, Angle of Attack (AOA) probes and Total Air Temperature (TAT) probe.

An ice optional detector is available to provide the flight crew with visual warnings of accumulating ice. Installed on the left forward cheek panel and powered by the AC electrical system, the detector probe vibrates at approximately 40,000 Hertz (Hz) with no ice accumulated. At this frequency, only ice can adhere to the probe, thus false warnings are eliminated. If ice should begin to accumulate on the probe, the resonate frequency will begin to drop, eventually reaching 39,867 Hz. At this threshold, an amber ICE DETECTED caution message is prompted for display on the Crew Alerting System (CAS) and detector probe heat is energized. Detector probe heat then melts away any accumulated ice, allowing the frequency to again increase to 40,000 Hz, shutting off probe heat. If the probe is still free of ice sixty seconds later, the ICE DETECTED CAS message is removed, indicating the airplane is clear of icing conditions.

Currently, there are production provisions for an ice detector "ICE DET" test button on the TEST panel (copilot side of center console [airplanes 1457 and subs]).

2A-30-20: Wing Anti-Ice System

1. General Description:

The wing anti-ice system provides ice protection for each wing by warming the leading edge with engine bleed air from the bleed air manifold. It consists of identical, independently operating left and right sides, each side having a tap into the bleed air manifold. Although separate and independent, the left and right sides are joined by a crossover duct installed downstream of the wing anti-ice control valves. This duct allows one side of the system to provide anti-ice protection for both wing leading edges.

The following units and components together compose this system:

- Engine Bleed Air Manifold
- Anti-Ice Sensors
- Anti-Ice Controllers
- Anti-Ice Servo Air Pressure Regulator and Torque Motors
- Anti-Ice Control Valves
- System Ducts and Piccolo Tubes
- Normal and Overheat Thermal Switches

2. Description of Subsystems, Units and Components:

A. Engine Bleed Air Manifold:

The engine bleed air manifold is supplied mid-stage air from each engine's 7th stage compressor section through the 7th stage check valve. Depending on conditions, high-stage air may also be supplied by each engine's 12th stage compressor through the 12th stage air control valve (often referred to as the HP valve).

In addition to supplying air for wing anti-icing, air from the bleed air manifold is used for crossbleed starting and airplane services such as air conditioning and pressurization.

B. Anti-Ice Sensors:

A wing anti-ice sensor is installed on the front beam (spar) of each wing to sense the temperature in the leading edge plenum. Each sensor is a thermistor, thus its resistance varies proportionally to its temperature.

With the wing anti-ice system operating, each sensor sends its associated anti-ice controller a low voltage signal that is proportional to the sensed temperature.

C. Anti-Ice Controllers:

Each anti-ice controller receives power from the Essential 28 VDC bus. The controllers receive low voltage signals from its associated anti-ice sensor, then convert that signal into a high output signal to command its associated anti-ice servo air pressure regulator and torque motor.

D. Anti-Ice Servo Air Pressure Regulator and Torque Motors:

The anti-ice servo air pressure regulator and torque motor controls the pressure to its associated anti-ice control valve using an electrical signal received from its associated anti-ice controller. The electrical signal is then converted into a pneumatic signal used to position the anti-ice control valve proportionally.

E. Anti-Ice Control Valves:

The anti-ice control valve is spring loaded closed and pneumatically powered open. It is electrically controlled by its associated (L/R) WING switch in the ANTI ICE section of the cockpit overhead panel. With the WING switch selected ON, the ON legend in the switch illuminates and a blue (L/R) WING A/I advisory message is displayed on CAS. The control valve is allowed to open and begins to seek a position determined by the pressure downstream of its associated servo air pressure regulator and torque motor. The control valve regulates wing leading edge temperature by controlling bleed air flow to its associated system ducts and piccolo tube. It also regulates downstream pressure to 23 psi any time upstream pressure exceeds this value.

F. System Ducts and Piccolo Tubes:

During normal operation, the left and right wing anti-ice systems are isolated from each other (upstream of the crossover duct) by the isolation valve. The left engine bleed air system supplies the left wing anti-ice system and the right engine bleed air system supplies the right wing anti-ice system. This isolation eliminates the problem two-engine flow-sharing. Should one engine bleed air system fail, however, opening the isolation valve allows the operative engine bleed air system to supply air to both wing anti-ice systems.

A crossover duct is installed downstream of the anti-ice control valves to join the left and right wing system ducts. The ability to join the two systems adds an additional safety feature to the system in that, as long as one control valve is operating, both wings will receive anti-ice air.

From the anti-ice control valve, regulated engine bleed air flows to both wing leading edges through ducts installed beneath the cabin floor. Perforated tubes (called piccolo tubes because of their appearance) inside the wing leading edges distribute the bleed air along the length of the wing leading edge.

Bleed air leaving the piccolo tube heats the leading edge skin, preventing ice formation. The air then circulates aft into the leading edge plenum (where the wing anti-ice sensor is located), eventually exhausting overboard through the wing's center section exhaust port (airplanes Serial Number [SN] 1000 through 1320 not having Aircraft Service Change [ASC] 381). On airplanes SN 1000 through 1320 having ASC 381 and airplanes SN 1321 and subsequent, the air is exhausted into the main landing gear wheel well area to minimize the possibility of frozen brakes.

G. Normal and Overheat Thermal Switches:

Each wing has an inboard and outboard overheat thermal switch and a combined normal/overheat thermal switch approximately mid-wing. All switches receive power from the Essential 28 VDC bus.

(1) Normal Thermal Switch:

When wing temperature reaches 100 ±5° F (38 ±3° C), a normal thermal switch (one in each wing) closes. This illuminates the associated blue WING WARM annunciator on the cockpit overhead panel. The temperature in the wing plenum is modulated (sensor to controller to torque motor to control valve) so that it remains at approximately 130° F (55° C).

(2) Overheat Thermal Switch:

If a malfunction occurs with an increase in wing plenum temperature, any of the three parallel-wired overheat thermal switches will close when the temperature reaches 180 ±5° F (82 ±3° C). This causes an amber L-R WING HOT caution message will be displayed on CAS.

On airplanes SN 1000, 1034, 1129 and subsequent and airplanes SN 1001 through 1128 having ASC 232, should two minutes elapse without the anti-ice duct temperature reaching 100 ±5° F (38 ±3° C), an amber L-R WING TEMP LOW caution message will be displayed on CAS.

3. Controls and Indications:

(See Figure 1 and Figure 2.)

A. Circuit Breakers (CBs):

Circuit Breaker Name:	CB Panel:	Location:	Power Source:
L WING ANTI-ICE	CP	J-14	ESS DC Bus
R WING ANTI-ICE	CP	K-14	ESS DC Bus

B. Caution (Amber) CAS Messages:

CAS Message:	Cause or Meaning:
L-R WING HOT	Wing anti-icing exhaust duct temperature is greater than 180° F (82° C).
L-R WING TEMP LOW **(1)**	Wing anti-ice exhaust duct temperature is still below 100° F (38° C) two (2) minutes after selection of the WING ANTI ICE switch(es) to ON (time delay).

NOTE(S):

(1) SN 1000, 1034, 1129 and subs; SN 1001-1128 having ASC 232.

C. Advisory (Blue) CAS Messages:

CAS Message:	Cause or Meaning:
L-R WING A/I	Wing anti-ice is ON.

D. Other Annunciations:

Annunciation:	Cause or Meaning:
LEFT/RIGHT WING WARM annunciator illuminated (cockpit overhead panel).	Wing anti-ice plenum in wing leading edge(s) has reached minimum operating temperature of 100° F (38° C).

NOTE:

A description of the Engine Instruments and Crew Alerting System (EICAS) can be found in Section 5 of Honeywell's SPZ-8000 (or SPZ-8400) Digital Automatic Flight Control System Pilot's Manual for the Gulfstream IV.

4. Limitations:

A. Flight Manual Limitations:

Operation of wing anti-icing is required if icing conditions are imminent, or immediately upon detection of ice formation on wings, winglets, or windshield edges.

B. Notes On Single Anti-Ice System Operation:

If only one wing anti-ice system (left side or right side) is operative (WING ANTI ICE switch selected ON), the operative side will have the associated blue WING A/I advisory message displayed on CAS; the inoperative side will not. This is because the power needed to generate the signal to display the message comes directly from the WING ANTI ICE switch.

Both wings will still receive wing anti-icing air due to the crossover duct. Normal temperature control for both wings will be carried out by the operative side's components. The WING WARM annunciator, however, will not illuminate for the inoperative side.

Overtemperature warning will still be active on both sides, because power for this function is not dependent upon WING ANTI ICE switch position. The amber WING TEMP LOW caution CAS message, however, cannot be displayed for the inoperative side (airplanes SN 1000, 1034, 1129 and subsequent and airplanes SN 1001 through 1128 having ASC 232).

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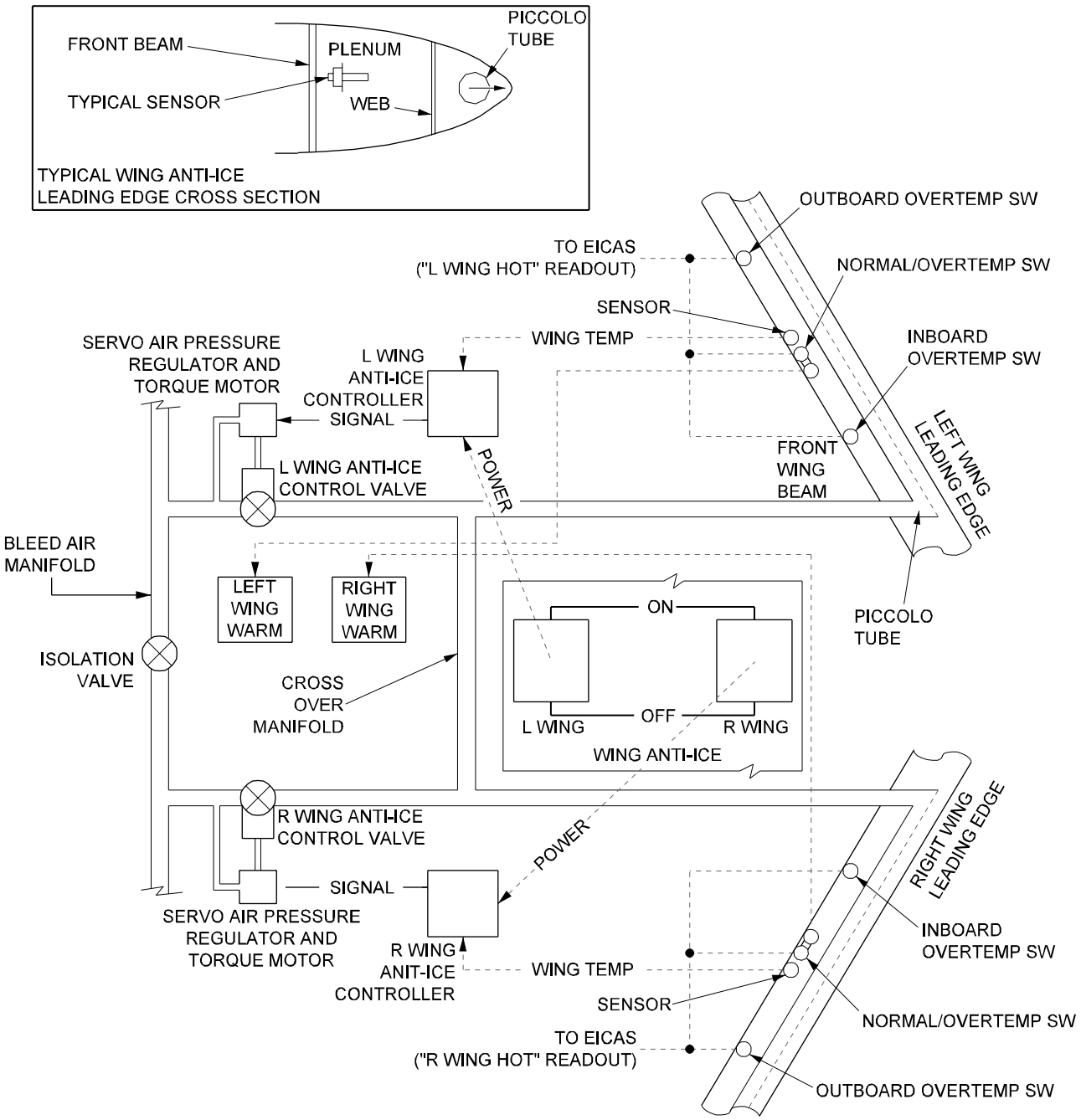

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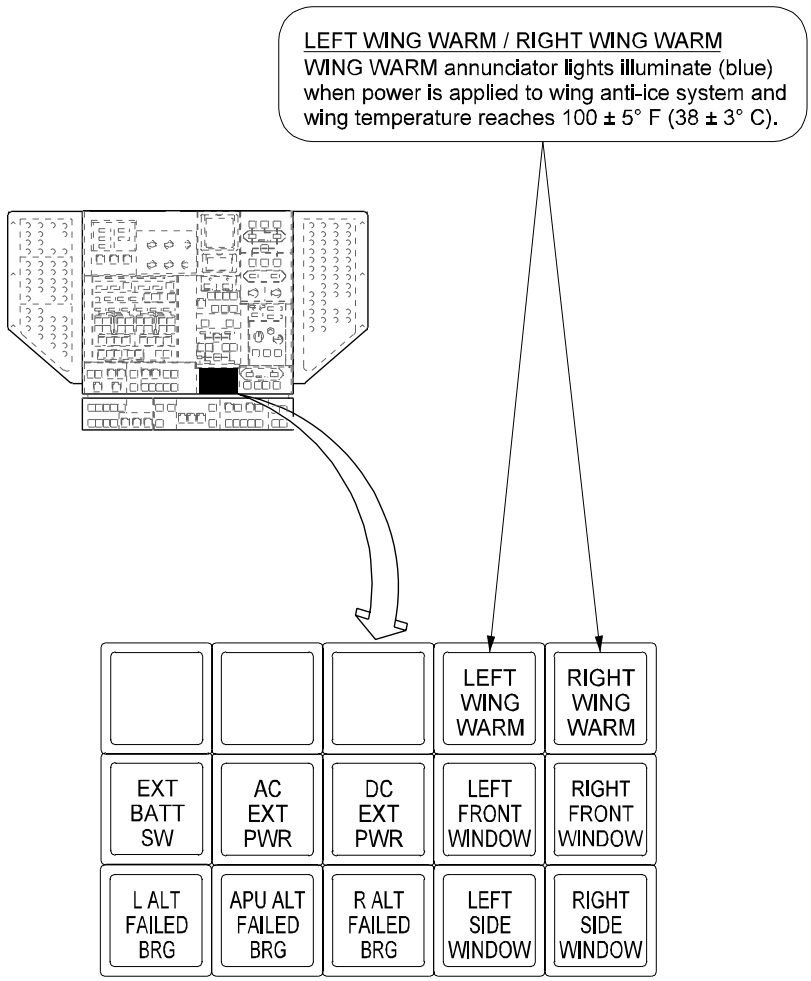
Wing Anti-Ice System
Simplified Block Diagram
Figure 1



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WING WARM Annunciators
Figure 2

2A-30-30: Cowl Anti-Ice System

1. General Description:

The cowl anti-ice system prevents the formation of ice on the engine nose cowl. This is accomplished by circulating engine bleed air from the bleed air manifold through the leading edge of the engine inlet.

The design of the Tay 611-8 engine does not feature inlet guide vanes to the Low Pressure (LP) compressor (fan), therefore an active ice protection system is not required. Any ice accumulation on the fan spinner is dislodged before reaching significant proportions by a flexible rubber tip on the spinner. The tip spins in an eccentric manner, making any ice accumulation asymmetric in shape. The asymmetric properties of the ice in turn causes it to be shed early in its development by centrifugal force.

The following units and components together compose the cowl anti-ice system:

- Cowl Anti-Ice Shutoff and Pressure Regulating Valves
- Cowl Anti-Ice Pressure Transmitters / Pressure Switches
- Cowl Anti-Ice Thermal Switches
- Nose Cowl Ducts and Piccolo Tubes

2. Description of Subsystems, Units and Components:

A. Cowl Anti-Ice Shutoff and Pressure Regulating Valves:

The cowl anti-ice shutoff and pressure regulating valve (commonly referred to as the cowl anti-ice valve) is spring loaded closed and pneumatically powered open. It is electrically controlled by its associated (L/R) COWL switch in the ANTI ICE section of the cockpit overhead panel. With the COWL switch selected ON, the ON legend in the switch illuminates, a blue (L/R) COWL A/I ON advisory message is displayed on CAS and a green A/I icon appears above the LP turbine digital scale on the engine instruments display. The control valve is allowed to open and begins to seek a position determined by sensed pressure downstream of the valve. During straight and level unaccelerated flight, regulated cowl anti-ice pressures of 16 to 22 psi are considered normal.

B. Cowl Anti-Ice Pressure Transmitters / Pressure Switches:

Cowl anti-ice pressure is tapped at the cowl anti-ice valve and sampled by a pressure transmitter in the engine cowl. Receiving power from the Essential 28 VDC bus, the pressure transmitter in turn supplies a signal to the cowl anti-ice pressure indicator located in the ANTI ICE section of the cockpit overhead panel.

On airplanes SN 1000 through 1059 having ASC 51A and airplanes SN 1060 and subsequent, a pressure switch is installed in each engine cowl. If cowl anti-ice is selected ON and pressure drops below 10±1 psi, the pressure switch will cause an amber L-R COWL PRESS LOW caution message to be displayed on CAS. On airplanes SN 1000 through 1189 having ASC 243 and airplanes SN 1190 and subsequent, the trip point is 4±1 psi (after an approximately 15 second delay). When pressure increases above the trip point - which normally occurs when thrust is increased - the message automatically clears. If increasing thrust does not increase pressure above 4 psi, the flight crew should depart icing conditions.

C. Cowl Anti-Ice Thermal Switches:

A thermal witch is installed downstream of each engine's cowl anti-ice valve to monitor the temperature of bleed air entering the nose cowl ducts. If the bleed air temperature exceeds 662°F (350°C), the thermal switch will cause an amber L-R COWL A/I OVHT caution message to be displayed on CAS.

D. Nose Cowl Ducts and Piccolo Tubes:

From the cowl anti-ice valve, regulated engine bleed air flows through ducts to the nose cowl. Perforated tubes (called piccolo tubes because of their appearance) inside the nose cowl distribute the bleed air along the circumference of the nose cowl leading edge, heating the leading edge skin and preventing ice formation. The air is vented overboard through the engine air inlet.

3. Controls and Indications:

(See Figure 4 and Figure 5.)

A. Circuit Breakers (CBs):

Circuit Breaker Name:	CB Panel:	Location:	Power Source:
L COWL ANTI-ICE	CP	J-13	ESS DC Bus
R COWL ANTI-ICE	CP	K-13	ESS DC Bus
L COWL A/I PRESS	CP	J-12	ESS DC Bus
R COWL A/I PRESS	CP	K-12	ESS DC Bus

B. Caution (Amber) CAS Messages:

CAS Message:	Cause or Meaning:
L-R COWL A/I OVHT	Engine cowl temperature is above 662°F (350°C).
L-R COWL PRESS LOW**(1)**	Cowl anti-ice pressure is less than 10±1 psi or 4±1 psi **(2)**.

NOTE(S):

(1) SN 1060 and subs; SN 1000-1059 having ASC 51A.

(2) SN 1190 and subs; SN 1000-1189 having ASC 243.

C. Advisory (Blue) CAS Messages:

CAS Message:	Cause or Meaning:
L-R COWL A/I ON	Cowl anti-ice is ON.

NOTE:

A description of the Engine Instruments and Crew Alerting System (EICAS) can be found in Section 5 of Honeywell's SPZ-8000 (or SPZ-8400) Digital Automatic Flight Control System Pilot's Manual for the Gulfstream IV.

4. Limitations:

A. Flight Manual Limitations:

(1) Requirements of Use:

Operation of the cowl anti-icing system is required for taxi and takeoff when Static Air Temperature (SAT) is below +8° C and visible moisture, precipitation, or wet runway are present. Engine operation at 85% LP for one (1) minute is recommended just prior to takeoff and at intervals of not more than sixty (60) minutes under these temperature and moisture conditions.

(2) Low Cowl Anti-Ice Pressure:

Depart icing conditions if COWL PRESSURE LOW message illuminates and cowl anti-ice pressure cannot be maintained at or above 4 psi.

NOTE:

The COWL PRESSURE LOW message illuminates at 4 psi on SN 1190 and Subs, and SN 1000 through 1189 with ASC 243. It illuminates at 10 psi on SN 1000 through 1189 without ASC 243. Cowl anti-ice is effective at 4 psi or greater.

(3) Use In Flight:

Use of cowl anti-icing system is required in flight as indicated in Figure 6: Temperature Range For Cowl Anti-Icing, when visible moisture or precipitation is present, or when signs of icing are observed. Ice accretion may be observed on wings or windshield edges.

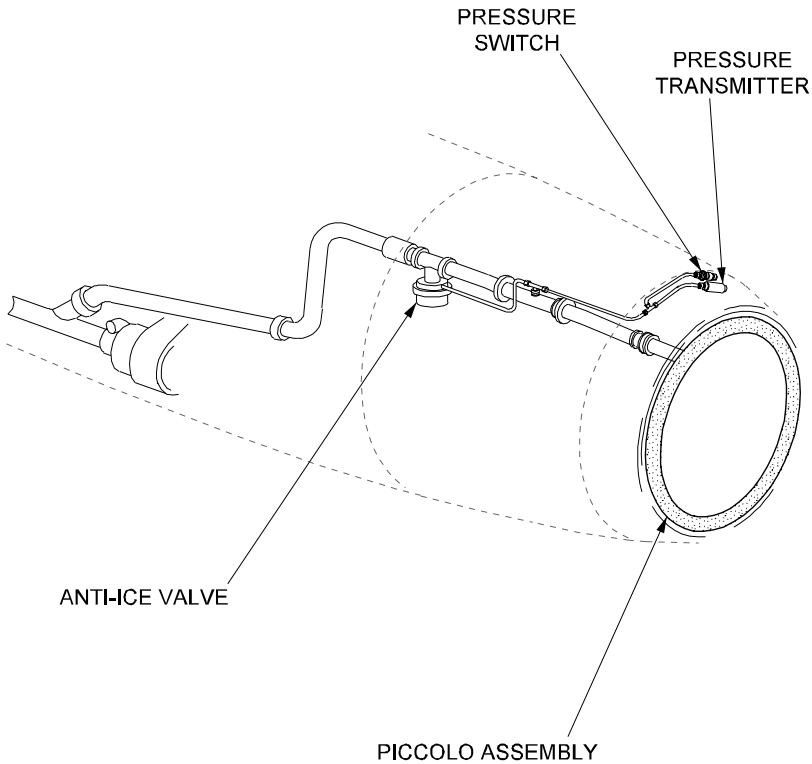
B. System Notes:

(1) Ice Formation During Idle Descents:

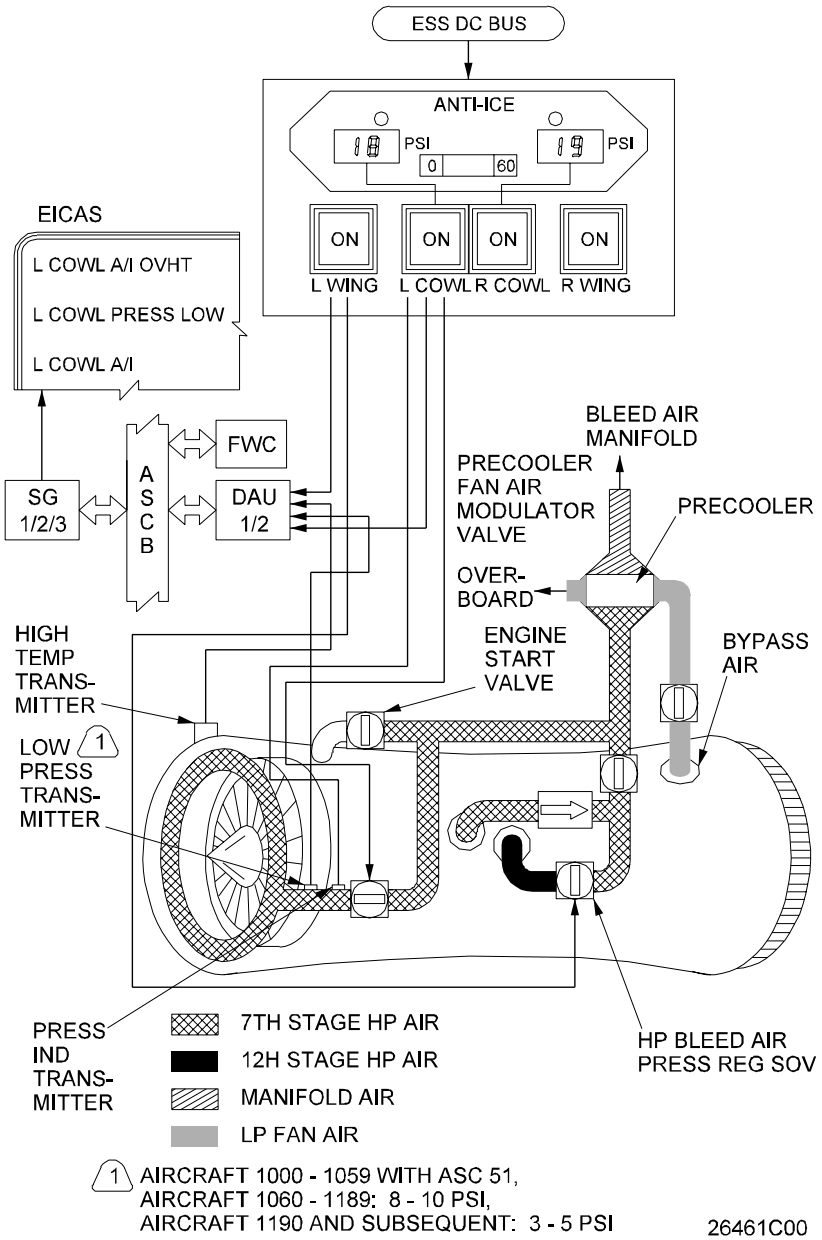
Although adequate bleed air for cowl anti-icing is available under all normal operating conditions, flight crews may note a limited amount of ice formation on the nose cowl during idle descents. When power is increased, some of this ice will be shed into the engine inlet. Shedding this limited amount of ice will not cause any adverse effects on engine operation.

(2) Icing and Engine Vibration:

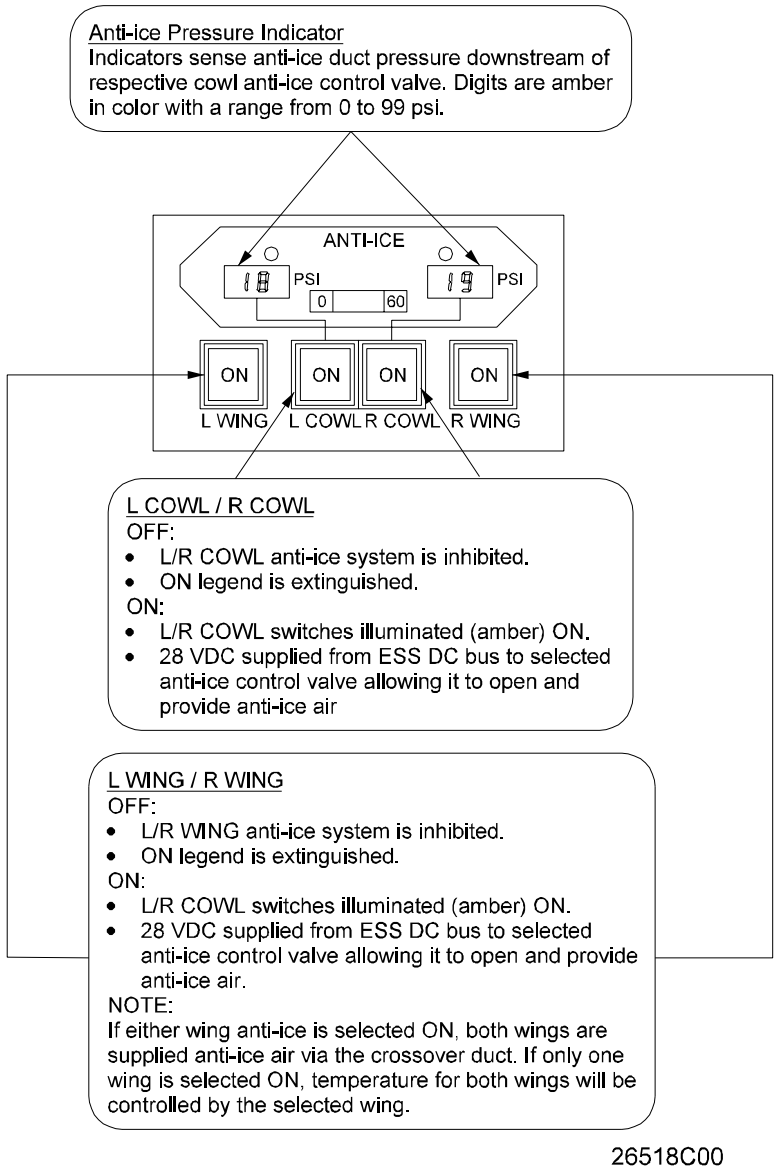
Increases in engine vibration level above 1.25 inches per second LP may develop in icing conditions. To assist in shedding ice, if sustained vibration is indicated and operational circumstances permit, retard one power lever at a time to IDLE for five (5) seconds and then restore to required thrust. Should the vibration still persist after doing so, momentarily adjust the thrust levels to 85% LP.



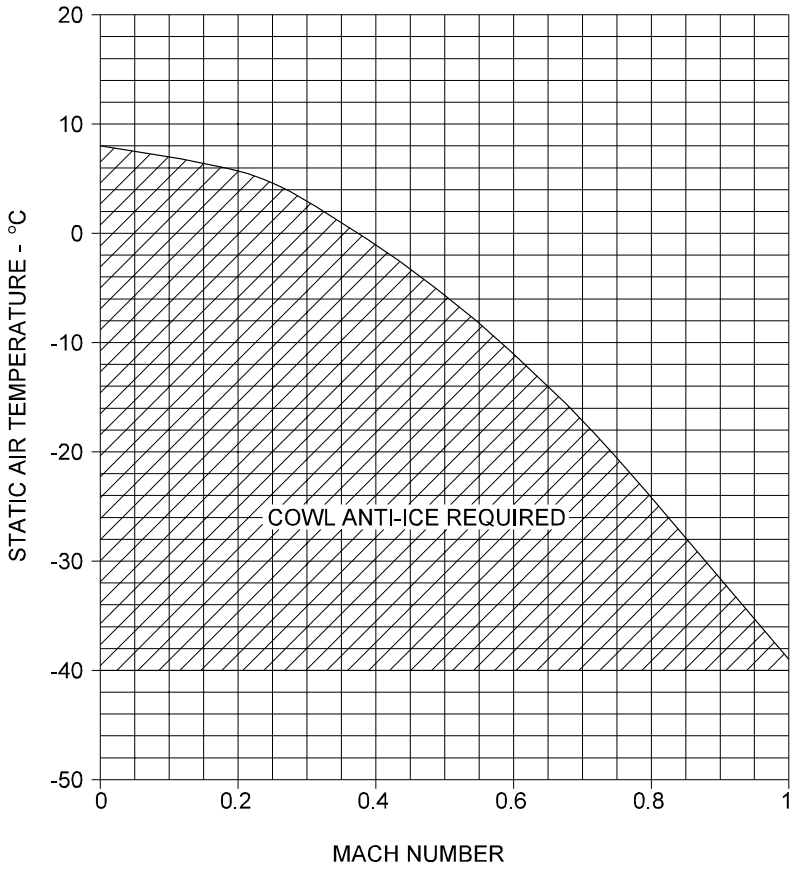
Cowl Anti-Ice System Layout
Figure 3



Cowl Anti-Ice System Simplified Block Diagram
Figure 4



Anti-Ice Control Panel
Figure 5



Temperature Range For Cowl Anti-Icing
Figure 6

2A-30-40: Windshield Ice and Rain Protection System

1. General Description:

The windshield ice and rain protection system provides deicing and defogging for the front windshields and side windows through the use of embedded electrical heating elements. Rain removal (front windshields only) is provided by a pair of electrically operated windshield wipers. The windshield ice and rain protection system is divided into the following subsystems:

- Windshield Heat System
- Windshield Wiper System

2. Description of Subsystems, Units and Components:

A. Windshield Heat System:

The windshield heat system automatically maintains front windshield and side window temperature for deicing and defogging. It is designed in such a manner that no single failure can cause total loss of windshield heat. It is not required for bird strike protection. The system consists of the following units and components:

- Heating Media
- Temperature Sensors
- Windshield Heat Controllers
- Windshield Heat Control Switch(es)
- Window Heat Advisory Lights

(1) Heating Media:

The left and right front windshields are constructed as laminates of three panes of glass and two interlayers. The outer pane is constructed of very thin but very strong glass. Should the glass be fractured, heating for that windshield will be lost. A conductive coating is applied on the inside surface of the outer pane. A bus bar at the top and bottom of each windshield distributes AC power from the associated windshield heat controller to the conductive coating. Two temperature sensors are also imbedded in each windshield.

The left and right side windows constructed as laminates of two acrylic layers with one interlayer and an Aircon heating mat sandwiched in between. A bus bar at the top and bottom of each window distributes AC power from the associated windshield heat controller to the heating mat. Two temperature sensors are also imbedded in each window.

(2) Temperature Sensors:

As stated above, two temperature sensors are imbedded in each windshield and window. They are normally referred to as the No. 1 and No. 2 sensors. Both sensors are connected to the windshield heat controller section serving that windshield/window. The windshield heat controllers use the No. 1 sensor for thermostatic control of the window. Should the No. 1 sensor circuit short or open, the windshield heat controllers switch to the No. 2 sensor with no interruption of service or notification to the flight crew. Should the No. 2 sensor then fail, the windshield heat controllers disable heat to that window and notify the flight crew by extinguishing the window heat advisory light.

On airplanes SN 1000 through 1155 having ASC 3 and ASC 275, SN 1156 through 1203 having ASC 275 and airplanes SN 1204 and subsequent, a temperature sensor test switch is incorporated. The switch is installed on the right-hand radio rack and is labeled W/S SENSOR TEST. With the windshield heat control switch(es) selected ON (OFF legend extinguished) and the TEST switch placed in either the SENSOR #1 or SENSOR #2 position, the associated sensor for each windshield and window is tested. Results of the test are obtained by observing the window heat

advisory lights. An illuminated advisory light confirms an operative sensor. If the advisory light does not illuminate, the light itself should be checked using the annunciator lights test switch. If the light tests satisfactorily, then a faulty sensor can be suspected and reported.

(3) Windshield Heat Controllers:

Two dual-unit heat controllers regulate AC power to the windshield and window heating media. The Left Front/Right Side (LF/RS) heat controller governs left front windshield and right side window heating; the Right Front/Left Side (RF/LS) heat controller governs right front windshield and left side window heating. Windshield/window temperature is maintained at 90-100°F (32-38°C) by the controller. Sensor monitoring and switching is also performed by the heat controller.

Remote Control Circuit Breaker (RCCB) logic units are incorporated as connection and protection devices for each window. Should a window draw current in excess of a preset value, the RCCB will disconnect that window by causing the system circuit breaker to pop.

On airplanes SN 1183 and subsequent, the Electrical Load Warning System (ELWS) is capable of automatically shedding windshield heat, if ON, to protect APU generating capabilities. At or above 34,000 feet (pressure altitude sensed by the Air Data Computer), the ELWS processor will automatically shed windshield heat based on the bus being powered by the APU alternator, i.e., RF/LS heat controller if the APU alternator is powering the Left Main AC bus, LF/RS heat controller if the APU alternator is powering the Right Main AC bus. Once at or below 32,000 feet PA, windshield heat is automatically restored.

Power for control and heat is provided by Left and Right Main AC buses as shown in the table that follows. Power for indication is provided by the Essential 28 VDC bus.

Windshield/Window	Control Power	Operating Power	Voltage
Left Front	Right Main AC, ϕC	Right Main AC, ϕB Right Main AC, ϕC	208 VAC
Right Side	Left Main AC, ϕA	Right Main AC, ϕC	115 VAC
Right Front	Right Main AC, ϕC	Left Main AC, ϕA Left Main AC, ϕB	208 VAC
Left Side	Left Main AC, ϕA	Left Main AC, ϕA	115 VAC

(4) Windshield Heat Control Switch(es):

(See Figure 7.)

For airplanes SN 1000 through 1095 (except SN 1001) not having ASC 239: A single WSHLD switchlight (cockpit overhead panel, ANTI ICE HTR section) controls power to both windshield heat controllers through two heat control relays: the left front/right side relay and the right front/left side relay. Selection to ON energizes the relays and extinguishes the amber OFF legend in the switchlight. Once energized, the relays supply power to their associated heat controller.

For airplanes SN 1001, SN 1096 and subsequent, SN 1000 through 1095 having ASC 239, and CAA certified aircraft: Two WINDSHIELD switchlights, LF/RS and RF/LS (cockpit overhead panel, ANTI ICE HTR section), control power to their associated windshield heat controller through four heat control relays: left side, left front, right front and right side. Selection to ON energizes the associated relays, extinguishes the amber OFF legend in the switchlight and supplies power to the associated heat controller.

(5) Window Heat Advisory Lights:

(See Figure 8.)

With windshield heat selected ON and the heat controllers supplying power to the windshield/window heating media, the LEFT FRONT, LEFT SIDE, RIGHT FRONT and RIGHT SIDE WINDOW annunciators (cockpit overhead panel) illuminate green to signal that heat is being applied to the window. The annunciators extinguish when the associated window reaches its normal operating temperature, and continue to cycle between illuminated and extinguished as heating power is applied and removed from the windshield/window heating media.

Each annunciator capsule contains four bulbs. Receiving power from the Essential 28 VDC bus, they are tested and controlled using the airplane's annunciator lights dim and test function.

B. Windshield Wiper System:

A pair of electrical windshield wipers remove precipitation from the left and right windshields. Being independent of each other, the left windshield wiper system receives power from the Essential 28 VDC bus; the right from the Right Main 28 VDC bus. Each system consists of the following units and components:

- Windshield Wiper Control Unit
- WIPER and LO/HI Control Switch
- Windshield Wiper Motor/Arm/Blade Assembly

(1) Windshield Wiper Control Unit:

The left and right windshield wiper control units each contain two relays that control wiper motor operation and speed in conjunction with the LO/HI control switch. A noise filter is incorporated to reduce any radio interference generated by wiper motor operation.

(2) WIPER and LO/HI Control Switch:

(See Figure 9.)

Each windshield wiper's operation and speed is controlled by a dedicated WIPER switch and associated LO/HI switch (cockpit overhead panel, WINDSHIELD WIPER section). The WIPER switch controls 28 VDC power directly to one side of the associated wiper motor and indirectly through the associated LO/HI switch and control unit relays to the motor. Selection of the WIPER switch to ON causes the associated wiper to operate at the speed determined by the associated LO/HI switch position. The ON legend illuminates blue.

With a wiper selected ON, selection of the WIPER switch a second

time extinguishes the ON legend in the switch and reverses the wiper motor, moving the wiper arm/blade assembly to the park position. Once in the park position, power is removed from the motor circuit.

The LO/HI switch controls a pair of relays within the associated control unit that manipulate the associated motor circuitry to achieve the desired wiper speed. When high speed is selected, the HI legend in the switch is illuminated blue.

(3) Windshield Wiper Motor/Arm/Blade Assembly:

The left and right windshield wiper motor/arm/blade assemblies are mechanically identical, but mirror images of each other and for the most part are not interchangeable. The left and right wiper blades, however, are identical.

When the wiper reaches the park position, a park switch in the motor breaks the motor power circuit and energizes an electrically actuated friction-type brake to prevent further motor movement. Should the wiper motor experience an overload, an internal thermo-protector temporarily de-energizes the motor. When the motor has sufficiently cooled, the thermo-protector automatically resets.

3. Controls and Indications:

(See Figure 7 through Figure 9.)

A. Circuit Breakers (CBs):

Circuit Breaker Name:	CB Panel:	Location:	Power Source:
L FRONT PWR **(1)**	CP	J-8	R MAIN AC Bus, ϕB
R SIDE PWR **(2)**	CP	K-10	R MAIN AC Bus, ϕC
L SIDE PWR **(3)**	CP	J-10	L MAIN AC Bus, ϕA
R FRONT PWR **(4)**	CP	L-8	L MAIN AC Bus, ϕB
L WSHLD WIPER	CP	J-11	ESS DC Bus
R WSHLD WIPER	CP	J-12	R MAIN DC Bus

NOTE(S):

(1) SN 1000-1095, excluding SN 1001 & 1034. For SN 1001, 1034 and SN 1096 & subs, CB is labeled L FRONT WSHLD.

(2) SN 1000-1071, excluding SN 1001 & 1034. For SN 1001, 1034 and SN 1072 & subs, CB is labeled R SIDE WSHLD.

(3) SN 1000-1071, excluding SN 1001 & 1034. For SN 1001, 1034 and SN 1072 & subs, CB is labeled L SIDE WSHLD.

(4) SN 1000-1095, excluding SN 1001 & 1034. For SN 1001, 1034 and SN 1096 & subs, CB is labeled R FRONT WSHLD.

4. Limitations:

A. Flight Manual Limitations:

There are no Flight Manual limitations for the windshield ice and rain protection system at the time of this revision.

B. System Notes:

(1) Care of Acrylic Surface of Cockpit Side Windows:

Exercise caution to guard against scratching the acrylic surface of the cockpit side windows when handling items normally adjacent to the windows, such as sunscreens and oxygen masks.

(2) Cabin Window Defogging:

Cabin window defogging is accomplished by passively drying the cabin air moving in and out of the space between the inner and outer panes of each cabin window. Pressure variances within the cabin resulting from normal airplane operation force cabin air through two desiccant dehydrators when entering and exiting the window enclosure.

(3) Windshield Wiper Operation:

The windshield wipers are effective at airspeeds of up to 200 KCAS. The windshield wipers should never be used when windshields are dry.

(4) Windshield Heat Operation:

On airplanes SN 1000 through 1273 not having ASC 126, electrical power transients may cause the windshield heat controller to latch in the full power OFF or full power ON modes. To prevent windshield damage after electrical power transients, select windshield heat OFF for two (2) seconds, then back ON. This resets windshield heat controller logic. On airplanes SN 1274 and subsequent and SN 1000 through 1273 having ASC 126, a one second time delay relay is installed to ensure the windshield heat controller has adequate time to reset itself, thus cycling power OFF and ON is not necessary.

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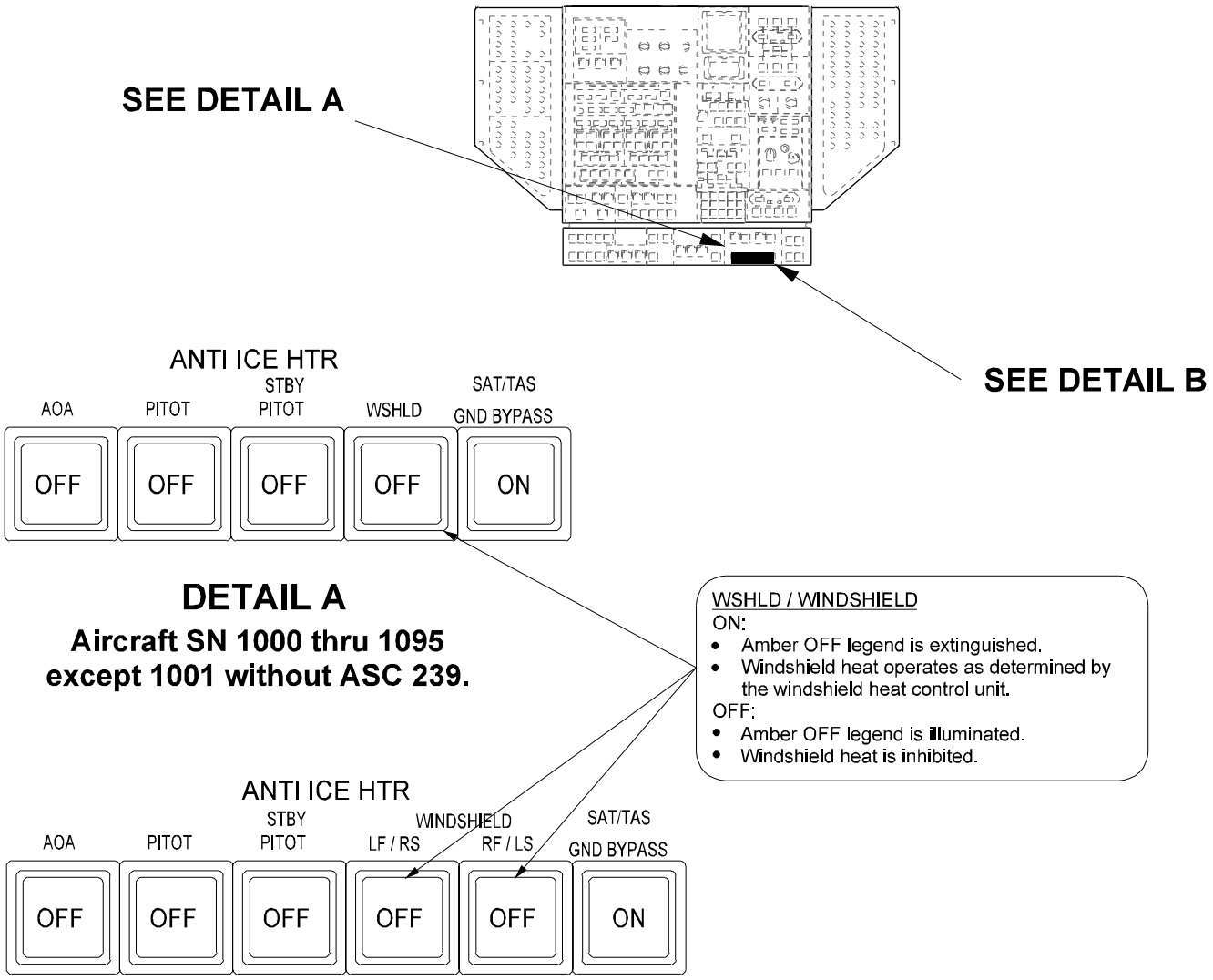

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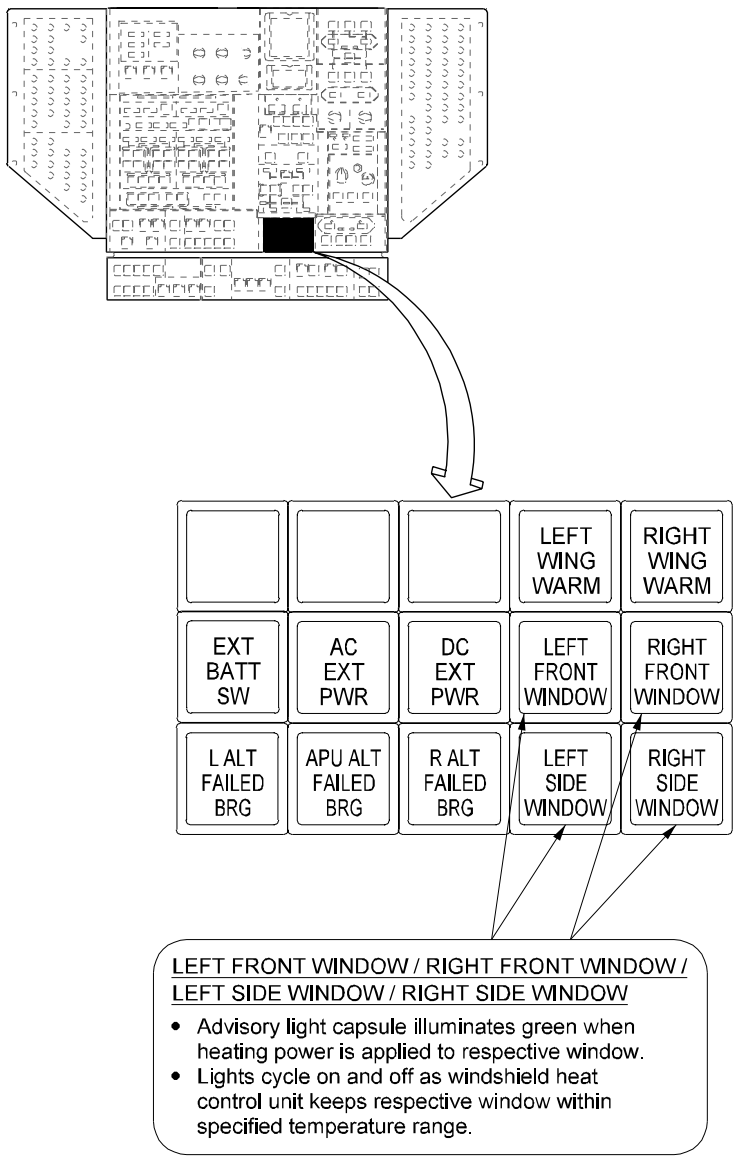
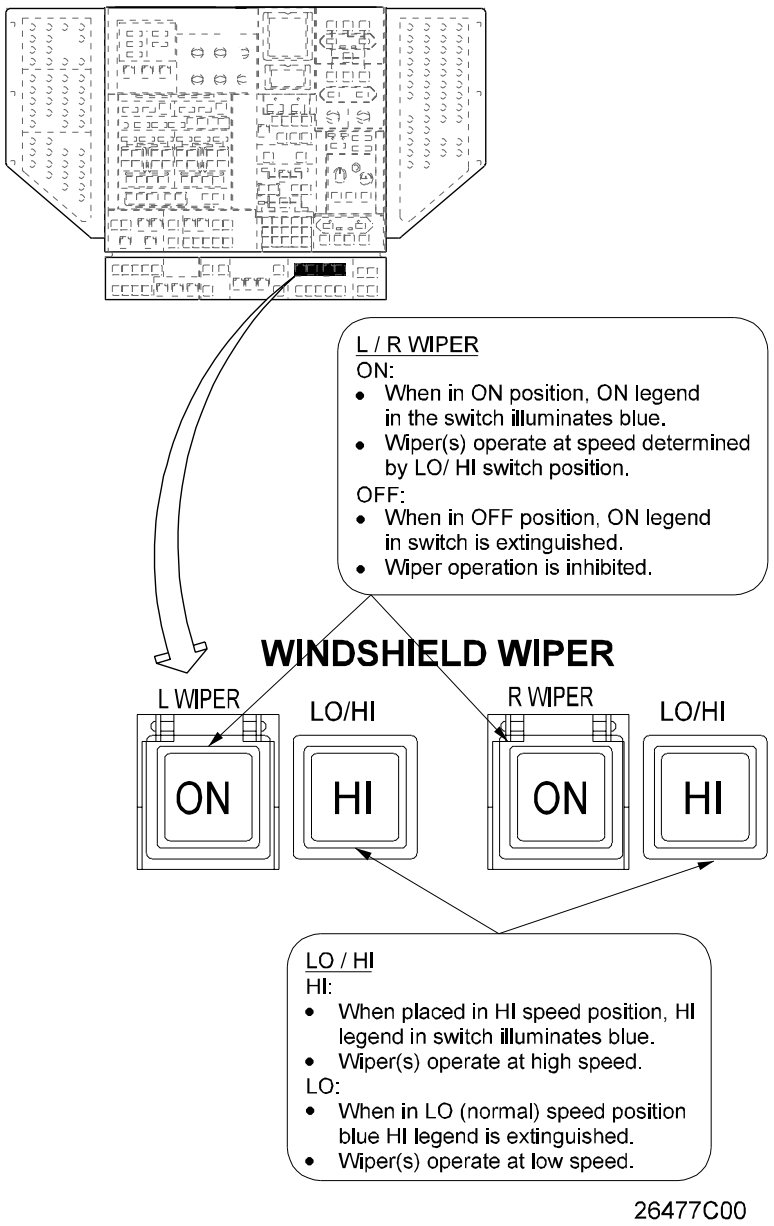
Windshield Heat Controls
and Indications
Figure 7



Window Heat Advisory Lights
Figure 8



Windshield Wiper System Controls and Indications
Figure 9

2A-30-50: Probe Anti-Ice System

1. General Description:

The probe anti-ice system uses electrically powered heating elements to protect the pitot probes, Angle of Attack (AOA) probes and Total Air Temperature (TAT) probe from ice accumulation.

2. Description of Subsystems, Units, and Components:

A. Pitot Probe Heat System:

The pitot probes are located on the nose of the airplane, just forward of the windshield. A third, standby pitot tube is located on the left forward fuselage.

The pitot probe heat system uses the PITOT and STBY PITOT switches (cockpit overhead panel, ANTI ICE section) and power relays to control AC electrical power to its resistance-type heating elements. Associated current sensors monitor current flow through the heating elements, cautioning the flight crew about out of range conditions through L-R PITOT HT FAIL and STBY PITOT HT FAIL caution Crew Alerting System (CAS) messages.

In addition to the CAS messages, the OFF legend in the PITOT switch plays a role in notifying the flight crew of pitot probe heat failures. On airplanes SN 1000 through 1143 not having Aircraft Service Change (ASC) 187, the OFF legend will illuminate if either the PITOT switch is selected OFF or if a **single or dual** heating element failure occurs. On airplanes SN 1144 and subsequent and SN 1000 through 1143 having ASC 187, the OFF legend will illuminate if either the PITOT switch is selected OFF or if a **dual** heating element failure occurs.

Selection of the PITOT switch to ON supplies 28 VDC power to energize the left and right pitot probe heat relays. Once energized, the relays extinguish the OFF legend in the switch and route single-phase 115 VAC power to the relay's associated heating element. (See Controls and Indications for specific control and operating power sources.) When the current sensors sense normal current flow through the heating elements, the associated L-R PITOT HT FAIL caution CAS messages are cleared.

Selection of the STBY PITOT switch to ON supplies Essential 28 VDC bus power to energize the standby pitot probe heat relay. Once energized, the relay extinguishes the OFF legend in the switch and routes Essential 115 VAC bus power to the heating element. When the current sensor senses normal current flow through the heating element, the STBY PITOT HT FAIL caution CAS message is cleared.

Airplanes having ASC 10 have a pitot heat inhibit relay installed that energizes when the outside battery switch is on the ON position. When energized, the relay opens the circuit between the PITOT and STBY PITOT switches and their associated probe heat relays.

B. Angle of Attack (AOA) Probe Heat System:

The AOA probes are located on either side of the forward fuselage.

The AOA probe heat system uses both a case heater and probe heater controlled by the AOA switch (cockpit overhead panel, ANTI ICE section) through two probe heat relays. Two thermal switches are also incorporated: one for the case to maintain a moisture-free environment within the case and one for the probe to prevent overheating.

Selection of the AOA switch to ON supplies Right Main and Essential 28 VDC bus power through the PITOT HT circuit breakers to the No. 1 and No. 2 probe heat relays. Once energized, the relay routes Right Main and Essential 28 VDC bus power to the case and probe heating elements. The OFF legend in the switch is then extinguished and the AOA HEAT 1-2 FAIL caution CAS message is cleared.

The case heater thermal switch cycles the case heating element on and off to maintain a case temperature of 90-125° F (32-52° C). By cycling heater power, condensation formation within the case and its resultant effect on probe operation are avoided.

The probe thermal switch prevents overheating by inhibiting heating element power at 280° F (138° C). When probe temperature drops below the trip point, power to the heating element is restored.

C. Total Air Temperature (TAT) Probe Heat System:

The TAT probe is located on the lower right side of the forward fuselage below the AOA probe.

The TAT probe heat system is a shared function of the pitot probe heat system. When in flight, selection of the PITOT switch to ON supplies Right Main 28 VDC bus power through the TAT probe heat relay through nutcracker relay No. 8. Once energized, the TAT probe heat relay routes single-phase Right Main 115 VAC bus power to the TAT probe heating element. When the current sensor senses normal current flow through the heating element, the TAT HT FAIL caution CAS message is cleared.

When the airplane is on the ground, selection of the SAT/TAS GND BYPASS switch (cockpit overhead panel, ANTI ICE section) to ON (ON legend illuminated) bypasses the nutcracker relay to allow TAT probe heating.

To ensure accurate calibration readings, air is introduced through the TAT probe when the airplane is on the ground. Through this process, known as aspiration, bleed air is supplied to the probe from a shutoff valve that opens when the nutcracker shifts to the ground mode. This shutoff valve, known as the “total temp valve”, receives its power from the Right Main 28 VDC bus.

3. Controls and Indications:

(See Figure 10.)

A. Power Sources:

Probe:	Switch:	Control Power:	Operating Power:
Left Pitot	PITOT	ESS DC Bus	ESS AC Bus ϕA
Right Pitot	PITOT	R MAIN DC Bus	R MAIN AC Bus ϕA
TAT	PITOT	R MAIN DC Bus	R MAIN AC Bus ϕB
Standby Pitot	STBY PITOT	ESS DC Bus	R MAIN AC Bus ϕA
Left AOA	AOA	ESS DC Bus	ESS DC Bus
Right AOA	AOA	R MAIN DC Bus	R MAIN DC Bus

B. Circuit Breakers (CBs):

Circuit Breaker Name:	CB Panel:	Location:	Power Source:
AOA PRB HTR #1	CP	L-14	ESS DC Bus
AOA PRB HTR #2	CP	M-14	R MAIN DC Bus
STBY PITOT HT CONT	CP	L-13	ESS DC Bus
STBY PITOT HT PWR	CP	M-13	R MAIN AC Bus ϕB
L PITOT HT CONT	CP	L-12	ESS DC Bus
R PITOT HT CONT	CP	M-12	R MAIN DC Bus
L PITOT HT PWR	CP	L-11	ESS AC ϕA
R PITOT HT PWR	CP	M-11	R MAIN AC Bus ϕA
TOTAL TEMP PROBE HTR	CP	L-10	R MAIN AC Bus ϕB
TOTAL TEMP VALVE	CP	M-10	R MAIN DC Bus

C. Caution (Amber) CAS Messages:

CAS Message:	Cause or Meaning:
L-R PITOT HT FAIL	Pitot tube heater elements not energized.
STBY PITOT HT FAIL	Standby pitot heater element not energized.
AOA HEAT 1-2 FAIL	Angle-of-attack probe heater has failed.
TAT PROBE HT FAIL	Total Air Temperature probe heater has failed.

4. Limitations:

A. Flight Manual Limitations:

There are no Flight Manual limitations for probe anti-ice system at the time of this revision.

B. System Notes:

(1) Loss of AOA Probe Heat In Flight:

If an AOA probe heater fails in flight and the associated CB is of no assistance, it is recommended that icing conditions be avoided, if possible. If flight into icing conditions is unavoidable, it is recommended that the stall barrier computer with the associated failed AOA probe heater be disabled through its associated CB and the operative system be monitored. Full stall barrier protection will still be provided by the operative system.

(2) Loss of Pitot Probe Heat In Flight:

If a pitot probe heater fails in flight, it is recommended that the flight crew be alert for erroneous indications from the airspeed indicator, air data system computer, airspeed warning sensor and Mach trim compensation.

(3) Loss of TAT Probe Heat In Flight:

If a TAT probe heater fails in flight and the associated CB is of no assistance, the flight crew should be aware that TAT inputs to the DADCs may be inaccurate which, in turn, may affect DADC outputs to the FMS. It is therefore recommended that the flight crew be alert for inaccurate readouts from the FMS.

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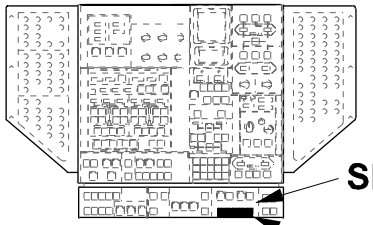

SEE DETAIL A

SEE DETAIL B

ANTI ICE HTR

AOA	PITOT	STBY PITOT	WSHLD	SAT/TAS GND BYPASS
OFF	OFF	OFF	OFF	ON

DETAIL A

Aircraft SN 1000 thru 1095 except 1001 without ASC 239

AOA
OFF:
- Amber OFF legend is illuminated.
- Heating power to probe and probe case is inhibited.

ON:
- Amber OFF legend is extinguished.
- Power is provided to left probe and probe case by Essential 28 VDC bus.
- Power is provided to right probe and probe case by Right Main 28 VDC bus.

STBY PITOT
OFF:
- Amber OFF legend is illuminated.
- Heating power to probe heating element is inhibited.

ON:
- Amber OFF legend is extinguished.
- Standby pitot heat power is provided by Right Main 115 VAC bus Ø B.

SAT/TAS GND BYPASS
OFF:
- Amber ON legend is extinguished.
- Power is provided through pitot heat system (while in flight only with pitot heat selected).

ON:
- Amber ON legend is illuminated.
- The nutcracker switch is bypassed and heating power is provided to the TAT probe.

PITOT
OFF:
- Amber OFF legend is illuminated.
- Heating power to probe heating element is inhibited.

ON:
- Amber OFF legend is extinguished.
- Left pitot heat power is provided by Essential 115 VAC bus $ A.
- Right pitot heat power is provided by Right Main 115 VAC bus $ A.

ANTI ICE HTR

AOA	PITOT	STBY PITOT	WINDSHIELD LF / RS	WINDSHIELD RF / LS	SAT/TAS GND BYPASS
OFF	OFF	OFF	OFF	OFF	ON

DETAIL B

Aircraft SN 1000 thru 1095 with ASC 239 and 1001, CAA certified aircraft and 1096 and sub.

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ANTI-ICE HTR Control Panel
Figure 10