General

Ice and rain protection consists of:

- Airfoil (wing and tail) anti-ice systems.
- Engine cowl anti-ice system.
- Air data heater system (pitot, static, TAT).
- Windshield/window anti-ice and defog systems.
- Windshield wiper system.
- Rain repellent system, if installed.
- Ice detection system, if installed.
- Miscellaneous heating systems.

The Environmental Systems Controller (ESC) monitors engine cowl anti-ice system operation.

The Pneumatic Systems Controller (PSC) monitors wing and horizontal stabilizer anti-ice system operation.

The Miscellaneous Systems Controller (MSC) automatically controls and monitors pitot tube, static port, and AOA heater operation.

Ice and rain protection controls are located on the forward overhead panel. Alerts are displayed on the Engine and Alert Display (EAD) and System Display (SD) to provide system status information to the crew.

The AIR cue switch illuminates when alerts related to wing, tail, engine anti-ice, and ice detection system (if installed) are displayed.

The MISC cue switch illuminates when alerts related to air data heaters, windshield heat, or defog are displayed.

As an optional installation, an automatic anti-ice system for airfoil and engine cowl ice protection is available.

Airfoil Anti-Ice System

The airfoil anti-ice systems consist of the wing anti-ice system and the tail (horizontal stabilizer) anti-ice system. Pushing the WING and TAIL ANTI-ICE switches ON prior to takeoff arms the airfoil anti-ice systems to function automatically when left and/or right ground sense mechanisms sense flight.

The two PSCs provide the following functions:

- Controls pneumatic system temperature and pressure requirements for ice protection.
- Monitors horizontal stabilizer anti-ice valve position.
- Monitors system ducts for leaks.
**Wing Anti-Ice System**

The wing anti-ice system provides ice protection for the outboard wing slats. Ice protection is not provided for the inboard slats.

Each wing has 8 leading-edge slats. The outermost slats (4 through 8) are anti-iced with hot engine bleed air. The bleed air source is either low stage air, high stage air, or low stage air augmented with high stage air, depending on the engine power setting.

The bleed air, drawn from the main pneumatic manifold, flows through a stainless steel duct to the piccolo duct. The piccolo duct, installed in the slats, controls the anti-ice airflow rate. The anti-ice air is discharged from the piccolo duct and through double skin passages. After leaving the double skin passages, the air is discharged overboard at the slat lower trailing edge.

Pushing the WING ANTI-ICE switch to ON before takeoff arms the airfoil anti-ice system to automatically function when the left and/or right ground sense mechanism senses flight. The system automatically turns off when the aircraft lands. An alert warns the flight crew if the system fails to shut off when on the ground. The slats may be damaged if the anti-ice system is on longer than 15 seconds while on the ground.

Normally the flight crew operates the wing anti-ice system manually, except during a Center Accessory Compartment (CAC) manifold fail condition. In this case, during the failure, wing anti-ice is turned off automatically in order to facilitate the automatic manifold decay check.

The wing anti-ice valves are armed on the ground or open during flight if selected on. The two wing anti-ice shutoff valves are normally opened and closed with the WING ANTI-ICE switch on the ANTI-ICE/WINDSHIELD control panel. The valves open only in flight, when pneumatic pressure is available. Pushing the WING ANTI-ICE switch opens the wing anti-ice valve. ON illuminates. DISAG illuminates when the open limit switch is tripped and the switch is off, or the closed limit switch is tripped and the switch is ON. A WNG A-ICE (L or R) DISAG alert is displayed.

On the ground, the WNG A-ICE DISAG alert is displayed and the DISAG light illuminates when an anti-ice valve is open, regardless of the switch position.

If wing anti-ice valve power fails, the valves fail in the closed position.

**Tail Anti-Ice System**

The tail (horizontal stabilizer) anti-ice system functions in the same manner as the wing anti-ice system.
Hot engine bleed air from pneumatic system 2 manifold is routed over the horizontal stabilizer box, diverging to right and left leading edges. Piccolo tubes, positioned along the leading edges, supply the hot engine bleed air.

Pushing the TAIL ANTI-ICE switch opens the horizontal stabilizer anti-ice valve. ON illuminates on the TAIL ANTI-ICE switch when the horizontal stabilizer is commanded open. DISAG illuminates on the TAIL ANTI-ICE switch when the switch is OFF and flow is sensed, or when the switch is ON and flow is not sensed. The TAIL A-ICE DISAG alert is displayed.

On the ground, the TAIL A-ICE DISAG alert is displayed and the DISAG light illuminates when an anti-ice valve is open, regardless of the switch position.

The ESC depressurizes pneumatic system 2 after 27 seconds if the anti-ice valve disagree condition continues to exist, and anti-ice air flow exceeds normal flow tolerances after duct pressurization and if a CAC manifold failure occurs. A tail manifold fail signal is transmitted to the PSC, which sends a signal to the ESC for annunciation and shutdown of pneumatic system 2.

The tail anti-ice shutoff valve fails closed if valve power fails.

**Engine Cowl Anti-Ice System**

The engine cowl anti-ice system uses hot engine bleed air (11th stage) incorporating a swirl system for cowl ice protection. Hot bleed air is ducted to the nose lip, where it is discharged by a nozzle, producing a swirling flow into the circumferential chamber (D-duct).

For engine 2 cowl anti-ice system, hot bleed air is ducted from the engine and discharged into the D-duct. The hot air then enters into a double skin passage through openings located in the inner skin. The anti-ice air is exhausted from the double skin passage into the aft compartment and vented overboard.

Engine cowl anti-ice valves are open when the flight crew selects the respective anti-ice system on. The engine cowl anti-ice valves are opened by pushing the appropriate ENG 1/2/3 ANTI-ICE switch. The anti-ice valve ON light illuminates on the switch when the valve is commanded open.

DISAG illuminates on the respective ENG 1/2/3 ANTI-ICE switch when the valve position (open or closed) does not agree with the commanded position. Momentary illumination of the DISAG light occurs while the valve is in transit.

The ESC inhibits an engine anti-ice DISAG annunciation while the FUEL switch is selected OFF. The DISAG annunciation is also inhibited for up to 45 seconds after the FUEL switch is selected ON (GE engines).

With the engine 2 anti-ice switch selected ON, if a leak is detected adjacent to anti-ice ducting for engine 2, causing the valve to automatically close (fuselage S75 and subsequent), the alert ENG 2 A-ICE OFF is displayed.
With the engine 2 anti-ice on or commanded OFF and not verified off, if a leak exists in the anti-ice ducting for engine 2, the alert ENG 2 A-ICE DUCT (fuselage 574 and previous) is displayed.

If electrical power to the valve fails, the valve fails open.

**Air Data Heater System**

The air data sensor heater system consists of integral heating elements within the pitot tubes, AOA sensors, and the TAT probe. Heaters are also mounted to the static pressure ports.

A Miscellaneous Systems Controller (MSC) automatically controls, monitors operation of the air data heater system and provides alerts to the flight crew.

The pitot tubes are installed on the underside of the fuselage. Each pitot tube is electrically anti-iced with two self-regulating heaters. Each pitot tube heater contains two elements which may be powered individually or in series. When on the ground, the elements operate in series to prolong their life.

The TAT probe and AOA sensors each contain a single heating element. On the ground, the TAT probe heater is not powered and the AOA heaters operate from 28-volt ac. In the air, the AOA heaters operate from 115-volt ac.

All static pressure port heaters contain dual heater elements.

The MSC turns on all air data heat (except TAT) when any engine FUEL switch is moved to ON. The MSC turns these heating systems (except TAT) off when all three engine FUEL switches are moved to OFF.

The MSC allows the TAT heat to be on only when the ground sense mechanism senses flight. However, maintenance personnel can override the MSC, as necessary, with switches on the maintenance panel.

**Windshield/Window Anti-Ice and Defog Systems**

The clearview windows and aft windows are equipped with a defog system only. The windshields are equipped with both defog and anti-ice systems.

All cockpit windshields/windows can withstand full airplane pressurization with one glass pane cracked.

The windshield anti-ice system (which may also be used for backup windshield defogging) consists of separate, independent, electrically-heated left and right windshields, selector switches, temperature controllers and temperature sensors.
A controller and sensor maintains the windshield at the correct temperature. The controller automatically provides ramp warm-up (gradually increasing) power to the windshield for three to four minutes during initial turn-on to minimize thermal shock. The controller automatically removes power from the windshield if an overheat condition occurs.

Windshield anti-ice can be selected on at NORM anti-ice heat or HIGH anti-ice heat without thermal shock to the windshield.

Appropriate alerts are displayed for windshield heat on and for failure conditions.

The windshields are constructed of a glass-vinyl-glass-vinyl-glass, layered configuration. A thin anti-ice heating film (stannous oxide) is on the inboard surface of the outer glass pane, next to the vinyl layer. Heating is accomplished by electrical potential across the resistive oxide film.

Defogging is accomplished by applying power to a similar conductive film on the outboard surface of the inner glass pane. The defogging system consists of elements and sensors in each windshield, clearview, and aft window and a controller for each window. A single DEFOG switch controls defogging. DEFOG should be on for all flight conditions.

Two switches (L/R WINDSHLD ANTI-ICE) on the lower maintenance panel allow maintenance personnel to switch between primary and spare (L and R) anti-ice heat sensors on each windshield. Six switches on the lower maintenance panel (L/R WINDSHLD, L/R CLEARVIEW, and L/R AFT WINDOW) allow maintenance personnel to switch between primary and spare (L and R) defogging heat sensors on each window.

**Windshield Wiper System**

A separate wiper system is installed for left and right windshields. Each wiper system is independently controlled by a WINDSHLD WIPE selector on the forward overhead panel. The wipers may be selected to OFF/SLOW/FAST (some airplanes), or OFF/INT/SLOW/FAST.

With wipers selected to OFF, the wiper and arm assembly move to the vertical, parked position.

Operation of the windshield wipers on a dry surface is not recommended.

**Ice Detection System**

**General**

If installed, the ice detection system determines when the wing, tail, and engine ice protection systems should be turned on or off.
The ice detection system is a dual detector system (left and right). Each detector system has an independent failure monitoring system. For the ice detection system to be considered the primary indicator of an aircraft-in-ice condition, both left and right ice detector systems must be operative.

Both left and right systems consist of a sensor in each wing engine cowl and a controller in the leading edge of the wing near the engine pylon area.

Both left and right ice detector controllers interface with the ESC. The system operates using 115-volt ac power.

The secondary method of detecting ice buildup on the aircraft is the monitoring of Outside Air Temperature (OAT) and humidity combined with visual inspection of the aircraft windshield wipers and window frames during flight. This method is used when both left and right ice detector systems are inoperative.

If one of the two systems fails, the flight crew must act based on the following:

- A single operative ice detector may be used for advisor information only.
- Monitoring of OAT and humidity.
- Visual inspection of windshield wipers and window frames.

If both left and right ice detector systems fail, the flight crew must rely entirely on the following:

- Monitoring of OAT and humidity.
- Visual inspection of windshield wipers and window frames.

In icing conditions, ice builds up on the sensing probe. The resonant frequency of the probe then decreases due to the added mass of the ice. When this frequency shift is sensed by the controller, an ICE alert is displayed if any airfoil or engine anti-ice switch is not on. Simultaneously, the probe starts to deice itself in preparation for the next ice detection cycle.

Heaters in the probe are powered for about ten seconds to melt the ice buildup. If during the next cycle, no ice is detected, a NO ICE DETECTED alert is displayed if the anti-ice system is commanded on.

An ICE DET SINGLE alert will warn the crew that one of the 2 systems has failed. An ICE DETECTOR FAIL alert will warn the crew that both ice detection systems have failed.

Ice detector system faults are stored in the ESC fault review.
System Operation

When electrical power is on, the ice detection system is operative. Powerup of the aircraft electrical system will automatically initiate a system powerup test. This test checks the system interface signals, the heater, and the software memory. If no faults are detected during the powerup test, the ice detection system begins normal operation for the detection of ice. If a fault is detected during the test, the ICE DET SINGLE or ICE DETECTOR FAIL alert will be displayed and the ESC will store the fault in fault review.

The ice detection system is operational on the ground. The system alerts are inhibited from display during takeoff and landing.

During normal operation, if an ice signal is transmitted from either the left or right ice detector controllers, the ICE alert will be displayed if any airfoil or engine anti-ice switch has not been turned on. As each ice protection system is selected on, a corresponding alert will be displayed showing status of the respective ANTI-ICE switch (this is in addition to switch illumination). When all the ice protection systems have been selected on, the individual alerts are replaced by a single alert, A-ICE ALL ON.

As the ice protection systems are operating, the sensor probe continuously cycles through the test for the detection of ice. If during the next cycle no ice is detected, a NO ICE DETECTED alert appears after the 60 second ICE signal timer has elapsed. This informs the flight crew that the ice protection systems may be selected off. This alert will stay on until all of the ice protection systems have been selected off.

If a single ice detection system fails, the ICE DET SINGLE alert is displayed. This tells the flight crew that the ice detection system is now an advisory system only and observation of windshields and window frames is also required to detect icing conditions. At the same time the fault is detected, the ICE and NO ICE alerts from the fault controller are inhibited.

If both ice detector systems fail, the ICE DETECTOR FAIL alert informs the flight crew that observation of windshields and window frames is required to detect icing conditions. When this alert is displayed the ICE and NO ICE alerts are inhibited.

If the ESC loses both digital data buses that transmit the ICE, NO ICE, and FAIL signals to the Display Electronic Units (DEU), an AIR ALERTS alert is displayed. In this case, the ice detection system cannot be used to determine if the aircraft is in icing conditions.
**Miscellaneous Heating Systems**

The forward, center, and aft lower cargo door latch actuators, as well as the forward and center lower cargo door sill drains, are electrically heated by a system powered through the 115-volt ac ground service bus.

The potable water system supply lines, drain lines, drains, and fill/drain valves are electrically heated. The system is powered through the 115-volt ac ground service bus. The potable water system vent/overflow and aft drain heaters are powered through the ground service bus by 28 volts dc.

**Automatic Anti-Ice Protection System (optional)**

The ice protection system automatically commands the wing, tail, and engine cowl anti-ice valves open when either of the two ice detection systems detect ice.

The automatic ice protection system consists of the following:
- Environmental System Controller (ESC).
- Ice detection system in conjunction with ANTI-ICE control panel.
- ANTI-ICE SYSTEM MANUAL switch on the overhead panel.

The automatic ice protection system provides the following:
- Indication.
- Fault detection monitoring.
- Test capability.
- Reconfiguration capability.
- Anti-ice system manual control.

The automatic ice protection system has a dedicated ANTI-ICE SYSTEM MANUAL switch on the overhead panel. This switch allows the flight crew to place the ice protection system in manual mode with the AIR control panel in auto mode.

The ice protection system operates in the auto mode when the AIR control panel is placed in auto.

The ice protection system reverts to manual mode for the following:
- The AIR control panel is selected or reverts to manual.
- Both ice detection systems are failed more than 60 seconds.

When the ice protection system reverts to manual, the system leaves the valves in their last commanded position. While in manual, the ESC does not command the anti-ice system valves.

When auto is selected, the ESC evaluates ice detection system status, and reconfigures the anti-ice valves.

The ESC does not use a failed ice detection system ICE signal to control wing, tail, or engine cowl anti-ice system valves.
Wing/Tail and Engine Cowl Anti-Ice Control System

The wing and tail anti-ice valves are armed on the ground or open in flight, and the engine cowl anti-ice valves are open for the following:

• When in auto and ice is detected.
• When in manual and the flight crew selects the respective anti-ice system on.

The ESC turns off the wing, tail, and associated engine cowl anti-ice system when the system is in auto and all three engines are not running.

Wing/Tail and Engine Cowl Anti-Ice System Failure

During automatic operation of the anti-ice system in icing conditions, the ICE DETECTED alert is displayed. When the ESC detects a condition which prevents an anti-ice valve from opening, ICE DETECTOR FAIL alert is displayed.

The ICE DETECTED alert is cleared when the ice detection system no longer detects icing conditions.

Airfoil Anti-Ice Valve Disagree

In flight, when operating in auto anti-ice in icing conditions and the ERSC detects a wing anti-ice valve failed closed for 25 seconds, the wing anti-ice system is commanded off and ICE DETECTED is displayed. On the ground, the ESC depressurizes the associated pneumatic system any time a valve is detected as failed open.

Wing or Tail Anti-Ice Manifold Failure

The ESC turns the associated anti-ice system off during a wing or tail anti-ice failure if the system is active. The associated pneumatic system is turned off if the failure continues, or, for a non active system.

ESC - CAC Manifold Failure Test Procedure

The ESC commands wing and tail anti-ice valves closed during a CAC manifold failure test procedure.

If the air system is in manual, the ESC cannot close the wing and tail anti-ice valves automatically. The valves have to be closed manually by the crew.

ESC - 1-2 Manifold Failure Test Procedure

For the duration of the test, during a 1-2 manifold failure test, the ESC commands the wing anti-ice system off when pneumatic system 1 is depressurized. The tail anti-ice system is commanded off when pneumatic system 2 is depressurized.
ESC - Single Manifold Failures
The wing anti-ice system is commanded off when the ESC senses a pneumatic system 1 or 3 manifold failure, or a left/right wing manifold failure. The tail anti-ice system is commanded off when the ESC senses a pneumatic system 2 manifold failure, or a tail manifold failure.

ENG FIRE Handle Operation
With the ice protection system in automatic mode, pulling an ENG FIRE or APU FIRE handle results in the associated engine being shut down. The respective engine cowl anti-ice system is unavailable when an engine is shut down.

The ESC turns off associated systems as follows:
- Engine 1 or 3 - wing anti-ice system.
- Engine 2 - tail anti-ice system.
- APU - tail anti-ice system.

SMOKE ELEC/AIR Selector Operation
Moving the SMOKE ELEC/AIR selector on the ELEC control panel from NORM turns off wing anti-ice. Returning the selector to NORM turns wing anti-ice back on.

Tail anti-ice is not available when 3/1 OFF or 1/2 OFF are selected.
Tail anti-ice operates normally when 2/3 OFF is selected.

DITCHING Switch
The ESC commands the associated wing and tail anti-ice systems off as pneumatic systems are shut down following selection of DITCHING ON.

Bleed Air Temperature High Operation
The ESC reverts the ice protection system and the air system to manual when a single bleed air source is feeding 2 or 3 pneumatic manifolds and a high temperature condition exists in an airfoil (wing or tail) anti-ice system bleed air source.

DEU Alerting
The A-ICE SYS MANUAL alert is displayed when the automatic anti-ice system is in manual.

The ICE DETECTED alert is displayed when, in automatic mode, any anti-ice system is not commanded on while ice condition is detected.

When the automatic anti-ice system opens a wing, tail, or engine cowl anti-ice valve, the following alerts appear:
- AIRFOIL A-ICE ON indicates wing and/or tail anti-ice valves are open.
• ENG 1/2/3 A-ICE ON indicates respective engine cowl anti-ice valve is open.
• ENGINE A-ICE ON indicates all three engine cowl anti-ice valves are open.
• A-ICE ALL ON indicates wing, tail, and engine cowl anti-ice valves are open.

Installation of an incompatible ESC on an airplane wired for the automatic anti-ice system causes the alert AIR ALERTS to be displayed. The -903 ESC and earlier are not compatible with the automatic anti-ice system.

Annunciator Controls

The ANTI-ICE SYSTEM MANUAL switch illuminates when the ice protection system is in manual mode. If in automatic mode, this switch blinks when a momentary switch on the ANTI-ICE control panel is pushed.

Status of the respective anti-ice valves is indicated on the ANTI-ICE control panel. WING and TAIL ANTI-ICE switches illuminate ON when commanded open/armed. ENG 1/2/3 ANTI-ICE switches illuminate ON when the associated engine cowl anti-ice valves are commanded open.

The PSCs provide wing and tail anti-ice disagree indication.

The ESC inhibits an anti-ice disagree annunciation when the FUEL switch is OFF, and up to 45 seconds after the FUEL switch is turned ON.

During automatic mode operation of the ice protection system, the ENG ANTI-ICE DISAG lights illuminate when commanded position disagrees with actual position for more than 15 seconds.

Automatic Anti-Ice System Panel Interface

The automatic ANTI-ICE system control panel ENG, WING, and TAIL ANTI-ICE switches are momentary action.

The ANTI-ICE SYSTEM MANUAL switch is a momentary switch with a single MANUAL light.

Ice Detection System Preflight Test (Optional)

The ice detection system is tested when the ANNUN LT TEST button is pushed until the AIR SYS TEST alert is displayed. This feature is introduced with ESC -904 and is functional on airplanes equipped with automatic anti-ice protection, or if selected as an option by the operator.

If the ESC senses one ice detection system as failed, the ICE DET SINGLE alert is displayed. The ESC does not use that system as input to control the automatic anti-ice protection system.
If the ESC senses both ice detection systems as failed, the ICE DETECTOR FAIL alert is displayed. The automatic anti-ice protection system reverts to manual mode.

If the alert ICE DET SINGLE or ICE DETECTOR FAIL was displayed due to a failure of the ice detection preflight test, the alerts are cleared under the following conditions:

- The preflight test is rerun and the ice detection systems pass the preflight tests.
- Maintenance has cleared the problem from the ESC faults screen on the CFDS.

A preflight failure of the ice detection system does not cause the AIR SYS TEST FAIL alert to be displayed.

The ice detection system preflight failures are remembered through the AIR control panel auto/manual/auto switch activations.

If the ANNUN LT TEST button is held for more than 1 minute, the alert ICE DETECTOR FAIL is displayed and remains displayed until 10 seconds after the button is released. This does not indicate an ice detection system failure.

**Airfoil Anti-Ice System Preflight Test (Optional)**

On airplanes without the automatic anti-ice system installed, an optional anti-ice system preflight test is initiated when the WING or TAIL anti-ice switches (alternate action) are pushed to ON. During the test, ground sensing is bypassed and the respective airfoil anti-ice valve opens. If the test is successful, DISAG is displayed above the respective anti-ice valve on the AIR synoptic. The respective anti-ice valve then closes.

On airplanes with the automatic anti-ice system installed, an optional anti-ice system preflight test is initiated when the WING or TAIL anti-ice switches (momentary) are simultaneously pushed to ON for 5 seconds. If there is no source for air pressure, the test is not performed.

The A-ICE SYS TEST alert is displayed during the airfoil anti-ice test. If the left or right wing or tail anti-ice systems are detected as failed, the A-ICE TEST FAIL alert is displayed.

The A-ICE TEST FAIL alert is not displayed for the following:

- System passes after retest.
- Airplane becomes airborne.
- The ice protection system is in manual mode (Auto anti-ice system installed).
- Current faults are accessed on the CFDS. (Auto anti-ice system installed).

These tests are not associated with the ANNUN LT test.
Engine 2 Anti-Ice Duct Overheat Detection

This system is effective on fuselage 575 and subsequent, with DEU -908 installed. Engine 2 supplies hot bleed air to the engine inlet through a double shrouded anti-ice duct which runs through the tail. This duct is continuously monitored for an overheat condition due to a burst or a leak by a Continuous Fire Detection unit (CFD) and its three associated sensing elements.

The outer shroud of the anti-icing duct is thinner than that of previous airplanes.

 NOTE: The CFD does not detect fire, only overheat.

The system consists of the CFD, sensing elements, and the cowl anti-ice valve. Annunciation of system status is provided by the Environmental System Controller (ESC), anti-ice control panel, and Electronic Instrument System (EIS).

The CFD is in the center accessory compartment and operates on 28-volt DC power. There are two overheat sensors below the engine 2 anti-ice duct and one above the duct.

When an overheat is sensed (about 310°F) the CFD closes the engine 2 cowl anti-ice valve when commanded on. DISAG illuminates on the ENG 2 ANTI-ICE switch (valve closed and commanded on). If the valve remains open during the overheat, due to a failure, the ENG 2 A-ICE DUCT alert is displayed.

A preflight test of the system is initiated when the ANNUN LT TEST button is pushed until the AIR SYS TEST alert appears. The ENG DUCT TST FAIL alert is displayed if the overheat detection system detects a preflight test failure.
Ice and Rain Protected Zone Locations

- FRONT WINDOW (RH AND LH)
- SLIDING SIDE WINDOW (RH and LH)
- FIXED SIDE WINDOW (RH and LH)
- HORIZONTAL STABILIZER LEADING EDGE (RH and LH)
- WASTE WATER DRAIN
- SLATS 4 through 8 (RH and LH)
- ENGINE NACELLES (all 3 engines)
- CAPT/FO STATIC PORTS (RH and LH)
- ALTERNATE STATIC PORT (RH and LH)
- ANGLE OF ATTACK SENSOR (RH and LH)
- TOTAL AIR TEMPERATURE SENSOR
- CAPT/FO/ALT PITOT TUBES
NOTE: The heated air enters the aft side of the D-duct bulkhead and flows outboard to the endcaps where it exits.
Probe and Sensor Locations

PITOT TUBES (3)

TOTAL AIR TEMPERATURE PROBE

CAPTAIN

FIRST OFFICER

STATIC PORT (2)
RIGHT AND LEFT SIDE

ALTERNATE STATIC PORT (2)
RIGHT AND LEFT SIDE

ANGLE OF ATTACK SENSOR (2)
RIGHT AND LEFT SIDE
ICE DETECTOR

ICE DETECTION CONTROLLER ACCESS

ENGINE INLET COWL LIP

SENSING ELEMENT
Water Line and Waste Drain Locations

NO. 2 ENGINE AND AFT ACCESSORY COMPARTMENT DRAIN

AFT FUSELAGE AND NO. 2 ENGINE COMPARTMENT DRAIN

APU COMPARTMENT DOOR

APU EXHAUST AREA

APU COMPARTMENT DRAIN

TAIL CONE (VIEW LOOKING UP)

DB1-2-1964
Anti-Ice/Windshield Control Panel

1. ENG ANTI-ICE Switch (3) - blue/amber
   The ENG ANTI-ICE switches are alternate action switches that open and close the respective cowl anti-ice shutoff valves.
   ON illuminates blue when engine anti-ice is on.
   DISAG illuminates amber when the anti-ice shutoff valve is in transit and remains illuminated if the valve position disagrees with the switch position.

2. WING and TAIL ANTI-ICE Switches - blue/amber
   The WING and TAIL ANTI-ICE switches are alternate action switches that open and close the wing and tail anti-ice shutoff valves.
   ON illuminates blue when the respective switch is on.
   Inflight, DISAG illuminates amber when the anti-ice shutoff valves are in transit, and when valve position disagrees with the commanded anti-ice flow.
   On the ground, DISAG illuminates amber when the valve is open, regardless of switch position.
   The associated pneumatic system turns off when the respective anti-ice manifold fails.
On the ground, pushing the WING or TAIL ANTI-ICE switch. The following occurs:

- Ground sensing is bypassed.
- The respective (WING or TAIL) anti-ice valve opens.
- Disagree (DISAG) appears above the respective (WING or TAIL) anti-ice valve on the AIR synoptic to indicate proper system function.
- The respective (WING or TAIL) anti-ice valve closes.

3. **ANTI-ICE SYSTEM MANUAL Switch - amber**

This momentary type switch (optional) allows selection of automatic or manual control of the wing, tail, and engine cowl anti-ice systems.

MANUAL illuminates amber if the anti-ice system reverts from auto to manual, or if the system is selected to manual. A-ICE SYS MANUAL is displayed on the EAD.

*NOTE: With installation of the automatic anti-ice system, the ENG, WING, and TAIL ANTI-ICE switches are momentary type in lieu of alternate action type.*

4. **WINDSHIELD DEFOG Switch - amber**

The WINDSHIELD DEFOG switch, an alternate action switch, turns defog power to the windshield on and off. WINDSHIELD DEFOG OFF illuminates amber when windshield defog is commanded off.

With electrical power applied to the airplane, the defog controllers are energized. Windshield defog automatically turns on and the WINDSHIELD DEFOG OFF light extinguishes. The inner panes of the windshields and window are heated.

5. **(L/R) WINDSHIELD ANTI-ICE Switches - blue**

The WINDSHIELD ANTI-ICE switch, an alternate action switch, turns power to the windshield anti-ice controller on and off. The switch illuminates blue when anti-ice is on normal or high (NORM or HIGH).

6. **WINDSHIELD ANTI-ICE HIGH/NORM Switch - blue**

The WINDSHIELD ANTI-ICE HIGH/NORM switch, an alternate action switch, provides high or normal anti-ice heat to the windshield. HIGH illuminates blue when the WINDSHIELD ANTI-ICE switch is on and high heat is selected. NORM illuminates blue when the WINDSHIELD ANTI-ICE switch is on and normal heat is selected.

HIGH position may be used to remove ice if NORM is inadequate.

Use of windshield heat prevents window fogging during a descent into high humidity conditions.
1. **WINDSHLD WIPE Selector - (Captain and First Officer)**

Each wiper has an OFF, SLOW, FAST and optional INT speed. When selected OFF, the wiper and arm assembly move to the vertical parked position.

Operation on a dry surface is not recommended.
1. **WINDSHLD & WINDOW HEAT SENSORS Switches - blue**

   Maintenance use only. Selects alternate heat sensor for respective ANTI-ICE or DEFOG system.
NOTE: The associated cue switch is shown in parenthesis (XXX) following the alert.

Red Boxed Alerts (Level 3)

ENG 2 A-ICE DUCT (AIR) - (Effective for aircraft fuselage 575 and subs) Leak in the engine 2 anti-ice duct. Engine 2 anti-ice valve is still open.

Amber Boxed Alerts (Level 2)

TAIL A-ICE DISAG (AIR) - Flow/no flow not in agreement with switch position.

WNG A-ICE L/R DISAG (AIR) - Flow/no flow not in agreement with respective switch position.

Amber Alerts (Level 1)

A-ICE SENSOR FAIL (AIR) - Anti-ice system monitor failure exists.

A-ICE SYS MANUAL (AIR) - Auto anti-ice system, if installed, reverts to manual during fault condition, or, is selected to manual by flight crew.

A-ICE TEST FAIL (AIR) - Indicates crew-activated airfoil anti-ice test failure, if installed. Wing or tail surface anti-ice may be inoperative.

AIR DATA HTR ON (MAINT) - An air data probe heater is on when it should be off.

AOA HEAT L/R FAIL (MISC) - Left/right angle-of-attack probe heater has failed.

ENG 1/2/3 A-ICE DISAG (AIR) - Respective engine (1/2/3) anti-ice valve in disagreement with commanded position.

ENG 2 A-ICE DUCT (AIR) - (Effective for aircraft fuselage prior to 575) Leak in the engine 2 anti-ice duct. A secondary shroud allows continued use of ice protection.

ENG 2 A-ICE OFF (AIR) - (Effective for aircraft fuselage 575 and subs) A leak is detected adjacent to engine 2 anti-ice duct, engine anti-ice valve is automatically closed, and engine 2 anti-ice switch is commanded on.

ENG DUCT TST FAIL (AIR) - (Effective for aircraft fuselage 575 and subs) Engine 2 anti-ice duct test has failed.
ICE DET SINGLE (AIR) - One channel of the dual ice protection system, if installed, is inoperative. The ice detection system is no longer primary for ice detection.

ICE DETECTED (AIR) - Icing conditions exist with an airfoil or engine anti-ice system not on. On airplanes with auto anti-ice system installed, and auto or manual anti-ice selected, ice is detected and one of the ice protection systems is not commanded on.

ICE DETECTOR FAIL (AIR) - Both channels of the dual ice detection system, if installed, are inoperative. Auto anti-ice, if installed, is inoperative.

NO ICE DETECTED (AIR) - Ice detection system, if installed, indicates icing conditions do not exist and one of the ice protection systems is commanded on. May turn anti-ice systems off.

PITOT HEAT AUX (MISC) - Auxiliary pitot heater is inoperative.

PITOT HEAT CAPT/FO (MISC) - Respective pitot heat is inoperative.

PITOT HEAT OFF (MISC) - The PITOT HEAT switch on the upper maintenance panel is in the OVRD OFF position.

TAT PROBE HEAT (MISC) - TAT probe heater is inoperative.

WSHLD DEFOG OFF (MISC) - WINDSHIELD DEFOG switch is in OFF.

WSHLD HEAT L/R FAIL (MISC) - Left/right windshield heater is inoperative.

Cyan Alerts (Level 0)

A-ICE ALL ON - All engine and airfoil ANTI-ICE systems have been commanded on.

A-ICE SYS TEST - Displayed on the ground when the flight crew selects airfoil anti-ice on. Initiates a 15-second automatic test of the airfoil anti-ice system, if installed.

AIRFOIL A-ICE ON - Wing and/or tail anti-ice has been commanded on.

ENG 1/2/3 A-ICE ON - Respective engine (1/2/3) ANTI-ICE switch is commanded on.

ENGINE A-ICE ON - All 3 ENG ANTI-ICE switches are ON.

WSHLD HEAT HI - L and/or R windshield heat is on and in the HIGH mode.

WSHLD HEAT ON - L and/or R windshield heat is on and in the NORM mode.
Pneumatic Diagram

- ENG 1
  - FAN BLEED
    - HI LO
    - ENGINE INLET ICE PROTECTION
    - OVERBOARD
    - ENG START (REF)
    - PRE-COOLER
    - OVERBOARD
    - HORIZONTAL STABILIZER ICE PROTECTION
    - WING ICE PROTECTION
- ENG 2
  - FAN BLEED
    - HI LO
    - ENGINE INLET ICE PROTECTION
    - OVERBOARD
    - ENG START (REF)
    - PRE-COOLER
    - OVERBOARD
    - HORIZONTAL STABILIZER ICE PROTECTION
    - AIR CONDITIONING, LAVATORY VENTS, CARGO COMPARTMENT HEATING, ETC.
- ENG 3
  - FAN BLEED
    - HI LO
    - ENGINE INLET ICE PROTECTION
    - OVERBOARD
    - ENG START (REF)
    - PRE-COOLER
    - OVERBOARD
    - APU SUPPLY
    - WING ICE PROTECTION

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