ICE AND RAIN PROTECTION

The anti-ice systems are designed to prevent ice formation on the pitot tubes, static ports, angle-of-attack probes, ram air temperature (RAT) probes, engines, wings, wing roots, horizontal stabilizer leading edges, windshields, and overboard water drain lines. The vertical stabilizer does not require anti-icing. The various anti-icing systems use electrical heating elements or hot engine bleed air, and are activated by switches and knobs on the instrument panels.

There are many engine instrument and crew alerting system (EICAS) messages that pertain to operation of the anti-icing systems. Some are discussed here, but most are covered in detail under Engine Indicating and Crew Alerting System (EICAS), in Section Three of this manual.

ICE AND RAIN PROTECTION

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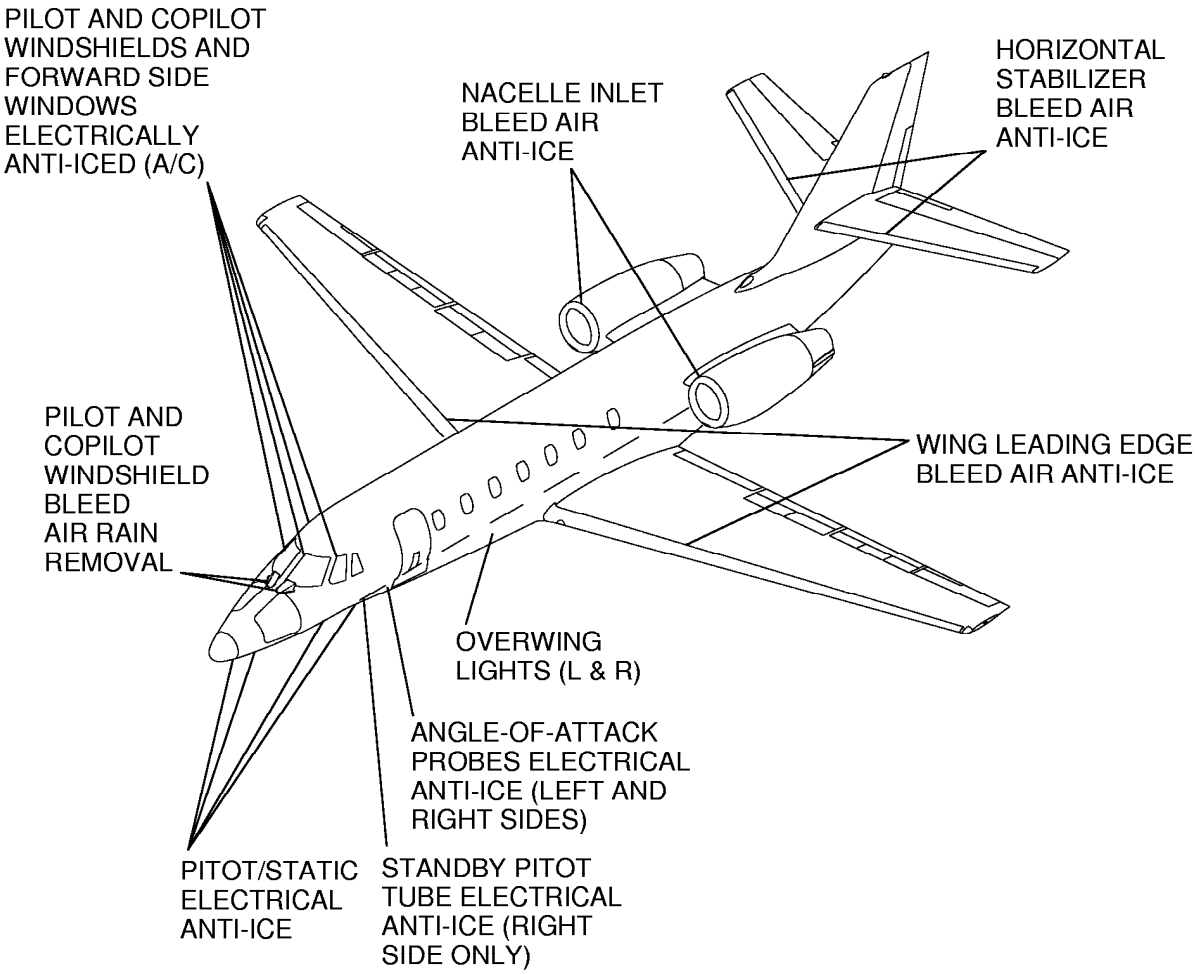

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Figure 2-23

ANTI-ICE CONTROL PANEL

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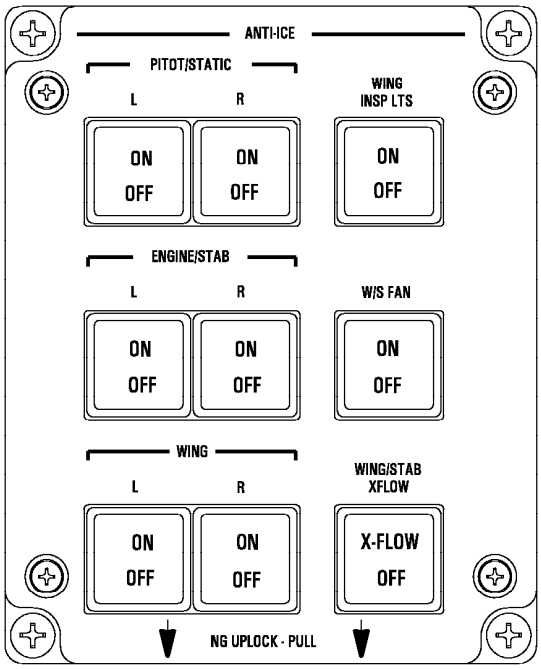

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Figure 2-24

DC electric power is used to anti-ice the pitot tubes and static ports, the AOA probes, the ram air temperature (RAT) probes. AC electric power is used for the cockpit windshields and front side windows. High-pressure, or low-pressure bleed air is used to anti-ice the wing leading edges, the wing-mounted landing lights, and the horizontal stabilizer leading edges.

Windshield, pitot/static and AOA anti-ice are normally operated full-time in flight.

PITOT-STATIC AND ANGLE-OF-ATTACK (AOA) PROBE ANTI-ICE

Electric elements heat the pilot and copilot pitot tubes, static ports, AOA probes, and standby pitot/static system. The L and R PITOT/STATIC ANTI-ICE switch-annunciators on the ANTI-ICE control panel located on the tilt panel to the right of the pedestal control the pitot and static heating elements. Selecting either switch activates the standby pitot/static anti-ice. If power is lost to the pitot heaters, static port heaters, or when a heater fails, an amber PITOT/STATIC COLD L-R-STBY CAS message will come on in the CAS (crew alerting system) portion of the EICAS display. The left and right AOA probe heaters are electrically powered, and are controlled by the respective side PITOT/STATIC L or R switch. If an AOA heater fails, the respective amber, AOA HEAT FAIL L-R CAS message, will appear. There are two messages that can appear if the pitot/static heaters are off. A cyan PITOT/STATIC COLD L-R-STBY CAS message indicates that the respective PITOT/STATIC switch-annunciator is in the OFF position. If the message is presented in amber, it means that the throttle lever angle is above 60° and the switch is OFF. In the latter case a chime will sound.

RAM AIR TEMPERATURE (RAT) HEATER

Electric elements heat the RAT probes, two per side, which are located in the engine inlet. A RAT heater is an integral part of each ram air temperature probe assembly. The Anti-Ice ENGINE/STAB L and R switches on the Anti-Ice control panel control the heating elements. The RAT heaters should be on in all icing conditions. If a RAT heater fails, the respective amber RAT HEAT FAIL L-R CAS message will be displayed.

BLEED AIR ANTI-ICE SYSTEM

Bleed air anti-ice is used to anti-ice the engine nacelle inlets, the wing leading edges, the landing light lenses, and the horizontal stabilizer leading edges.

Because they cannot be monitored for ice formation, engine inlet and horizontal stabilizer anti-ice should be turned on any time icing conditions are encountered.

Both engines contribute equally to the high- or low-pressure air supply. In the event of single-engine operation, wing and horizontal stabilizer crossover valves (WING/STAB XFLOW) are provided. These valves enable the use of either engine to supply bleed air for the wing leading edge and horizontal stabilizer leading edge. The bleed air for the wing and horizontal stabilizer system is temperature controlled by being passed through a pylon-mounted heat exchanger. The anti-ice system primarily utilizes high-pressure (HP) bleed air, except that low-pressure (LP) bleed air is used on the ground at mid to high throttle settings and in flight at high throttle settings below 25,000 feet. The precooler regulates fan air through the heat exchanger to control the bleed air to 475°F (±25°F) (246°C (±14°C)). Bleed air leaves the precooler and passes through a pressure regulating valve into a supply duct, which then distributes the air to the selected anti-ice systems.

Bleed air source selection (HP or LP) is automatically controlled when anti-ice is selected on based on throttle lever angle (TLA), weight-on-wheels (WOW) input from switches on the landing gear, and altitude input from the air data computers. The bleed air control rotary knobs on the copilot tilt panel can override automatic source selection. The engine HP shutoff valve (left and right) is commanded open or closed based on TLA, WOW input, aircraft altitude or the bleed air select knobs. Depending upon the sensing of the WOW switches and TLA position, the anti-ice air will be provided by either low-pressure or high-pressure engine bleed air. High-pressure engine bleed air is provided on the ground from idle up to mid throttle settings (33.5° TLA). On the ground, as the throttle lever is increased above the mid throttle position (33.5° TLA), power is provided to the HP shutoff valve, causing it to close, and low pressure bleed air is then provided for anti-ice.

When the airplane becomes airborne, LP bleed air will continue to be supplied for anti-ice purposes at TLAs above CRU detent while below 25,000 feet. Above 25,000 feet HP bleed air is supplied exclusively for anti-ice purposes regardless of TLA. When the WING/STAB XFLOW switch is selected to XFLOW, HP bleed air is supplied exclusively for anti-ice purposes regardless of TLA or altitude.

ENGINE ANTI-ICE

Anti-icing of the engine inlet lip and starter/generator inlet duct is provided by a piccolo tube that sprays bleed air onto the inside surface of the inlet lip skin. Bleed air for the engine inlet is taken upstream of the precooler. The air is therefore delivered to the inlet skin at nearly bleed port temperatures. After the air passes through the piccolo tube, it is then ducted aft through holes in the forward inlet bulkhead to louvers in the forward engine inlet skin that discharge the air overboard. The engine spinner and stator vanes are anti-iced by air supplied internal to the engine.

The engine anti-ice is controlled by the Anti-Ice ENGINE/STAB L and R switches located on the Anti-Ice tilt panel, which control the engine nacelle pressure regulating shutoff valves. The valves are powered to the closed position. With the switches in the ON position, power is removed from the valves and they move to the open position. With the switches in the OFF position, the engine nacelle regulating and shutoff valves will be electrically powered closed, regardless of throttle position, and engine anti-ice will be turned off.

In case of complete electrical power failure in flight, the control valves, which are held closed by electrical power, will then fail open and engine anti-ice will be automatically provided.

Cyan and amber ENG ANTI-ICE COLD L-R and amber ENG ANTI-ICE O'TEMP L-R CAS messages monitor engine inlet anti-ice temperature. A temperature sensor monitors the engine inlet anti-ice bleed air exhaust air temperature. Engine anti-ice overtemperature protection is provided at all times, regardless if the system has been selected on or not. If an amber ENG ANTI-ICE O'TEMP CAS message is displayed, the engine inlet anti-ice valve will automatically close, if it is functioning normally, until the overtemperature has cleared. Once the inlet has cooled, the system will automatically re-open the valve. On the ground, the cyan ENG ANTI-ICE COLD CAS message will display immediately after selecting the respective Anti-Ice ENGINE/STAB L or R switch ON until the respective surface has passed the pre-flight check and has reached a safe operating temperature for takeoff. In flight, the amber ENG ANTI-ICE COLD CAS message will display to notify the crew of an undertemperature condition 2.5 minutes after selecting the respective Anti-Ice ENGINE/STAB L or R switch ON. The cyan or amber ENG ANTI-ICE COLD CAS message will only be displayed if the system is selected on.

The inboard wing leading edge, in front of the engine, is considered a part of the engine anti-ice protection system. It is heated by precooled engine bleed air when the Anti-Ice ENGINE/STAB L and R switches are selected ON. The leading edge mounted landing lights are located in the inboard leading edge section and are anti-iced by diffusing bleed air from a dedicated piccolo tube. The inboard wing leading edge is monitored by amber INBD WING ANTI-ICE COLD L-R and WING ANTI-ICE O'TEMP L-R CAS messages. The temperature sensors are located on the wing leading edge skins and the wing front spar. If the amber WING ANTI-ICE O'TEMP CAS message is displayed, the inboard wing anti-ice valve will automatically close, if it is functioning normally, until the over-temperature has cleared.

Once the inboard wing has cooled, the system will automatically re-open the valve. This message is active at all times. On the ground, the cyan INBD WING ANTI-ICE COLD L-R CAS message will display immediately after selecting the respective Anti-Ice ENGINE/STAB L or R switch ON until the respective surface has passed the pre-flight check and has heated to a safe temperature for takeoff. In flight, the amber INBD WING ANTI-ICE COLD L-R CAS message will display to notify the crew of an undertemperature condition after a time delay has elapsed after selecting the respective Anti-Ice ENGINE/STAB L or R switch ON.

Engine anti-ice, as the name implies, is designed as a preventative system. Its use should be anticipated and the system actuated any time the airplane is operated in snow or freezing precipitation on the ground or when flight in visible moisture, with RAT temperatures 10°C to -35°C (50° to -31°F) is either occurring or is imminent.

Because of lower power settings during descent, it is advisable to turn on the engine anti-ice system well before entering a visible moisture environment where icing conditions may be anticipated.. Per Airplane Flight Manual procedures the anti-ice system must be selected on at least one minute prior to an idle descent into icing conditions.

Because of engine bleed air extraction with system operation, maximum allowable power settings are reduced as shown in Section IV Performance, Standard Charts of the Airplane Flight Manual.

The engine ignition should be turned on when flying in heavy rain, as a precaution against flameout.

WING ANTI-ICE

The wing anti-ice system consists of the bleed air heated outboard wing leading edge. The Anti-Ice WING L-R switches located on the anti-ice tilt panel control these systems. The wing anti-ice systems should be selected on when the airplane is operated in snow or freezing precipitation on the ground or anytime the airplane is flown in visible moisture with RAT temperatures +5° to -35° C (41° to -31° F). Wing anti-ice operation requires the Anti-Ice ENGINE/STAB L and R switches to be selected ON.

The wing leading edges are heated by precooled engine bleed air whenever the respective wing anti-ice is selected on. Wing anti-ice temperature is monitored by amber WING ANTI-ICE COLD L-R and WING ANTI-ICE O'TEMP L-R CAS messages. The temperature sensors monitor the wing leading edge skin and the wing front spar. If an amber WING ANTI-ICE O'TEMP CAS message is displayed, the wing anti-ice valve will automatically close, if it is functioning normally, until the over-temperature has cleared. Once the wing has cooled, the system will automatically re-open the valve. This message and automatic protection are active at all times. On the ground, the cyan WING ANTI-ICE COLD CAS message will display immediately after selecting wing anti-ice on until the system passes the pre-flight check and the respective surface has heated to a safe temperature for takeoff. In flight, the amber WING ANTI-ICE COLD CAS message will display to notify the crew of an under-temperature condition after a time delay has elapsed after selecting wing anti-ice on. The WING ANTI-ICE COLD CAS message is only active when the system has been selected on.

The wing air anti-ice system is fed by the high-pressure and low-pressure bleed air systems, which are discussed under Bleed Air Anti-ice System, above, in this section.

The left and right wing leading edge sections are anti-iced with engine bleed air supplied to two piccolo tubes, one each side, located in the left and right wing leading edge.

The normally closed wing crossover valve, located in the crossover duct between the left and right wing, normally isolates the left and right wing anti-ice systems. With the crossover valve open, either or both engines can supply either wing anti-ice system. Check valves, located in the wing supply tube at the forward end of the wing, prevent bleed air from the right system from entering the left system and vice versa. Heat from the wing leading edge is isolated from the wing structure and the fuel barrier, by a heat shield. In case of complete electrical power failure, the fail-safe position of the wing crossover valve is to the closed position. It is powered open, and upon electrical power failure will close.

With only engine anti-ice selected on, the engine and inboard wing cold messages will normally remain extinguished at idle. Depending on the flight condition, the idle engine power setting may not provide sufficient heat to keep the WING ANTI-ICE COLD L-R and STAB ANTI-ICE COLD L-R CAS messages from being displayed. The throttles may have to be increased slightly above idle to keep all cold messages extinguished. The COLD CAS messages indicate that the wing and/or stab surface temperature is too low, which is probably caused by a power setting that is too low. Increasing engine power can clear the condition.

ANTI-ICE SYSTEM SCHEMATIC

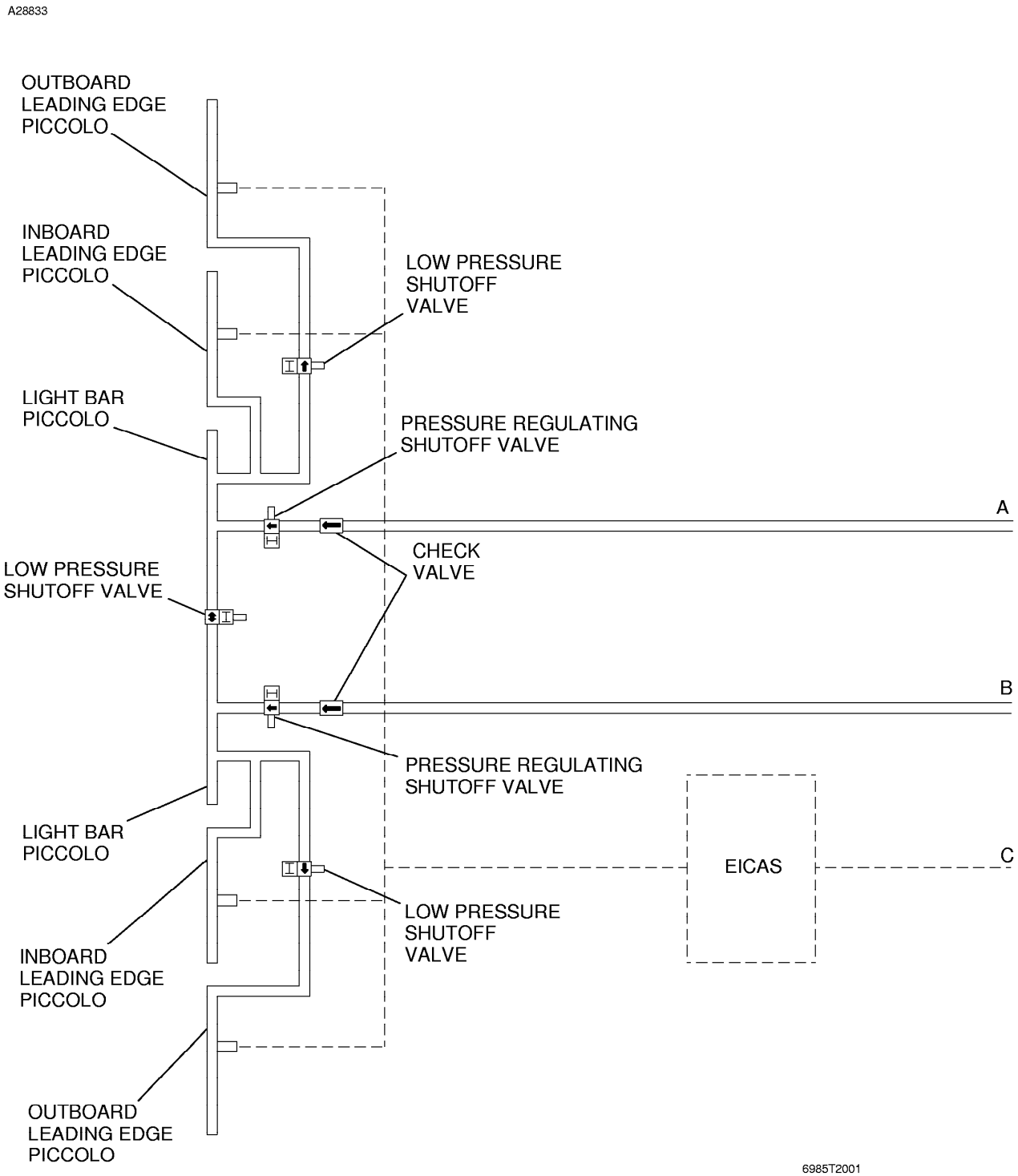

Figure 2-25 (Sheet 1 of 2)

ANTI-ICE SYSTEM SCHEMATIC

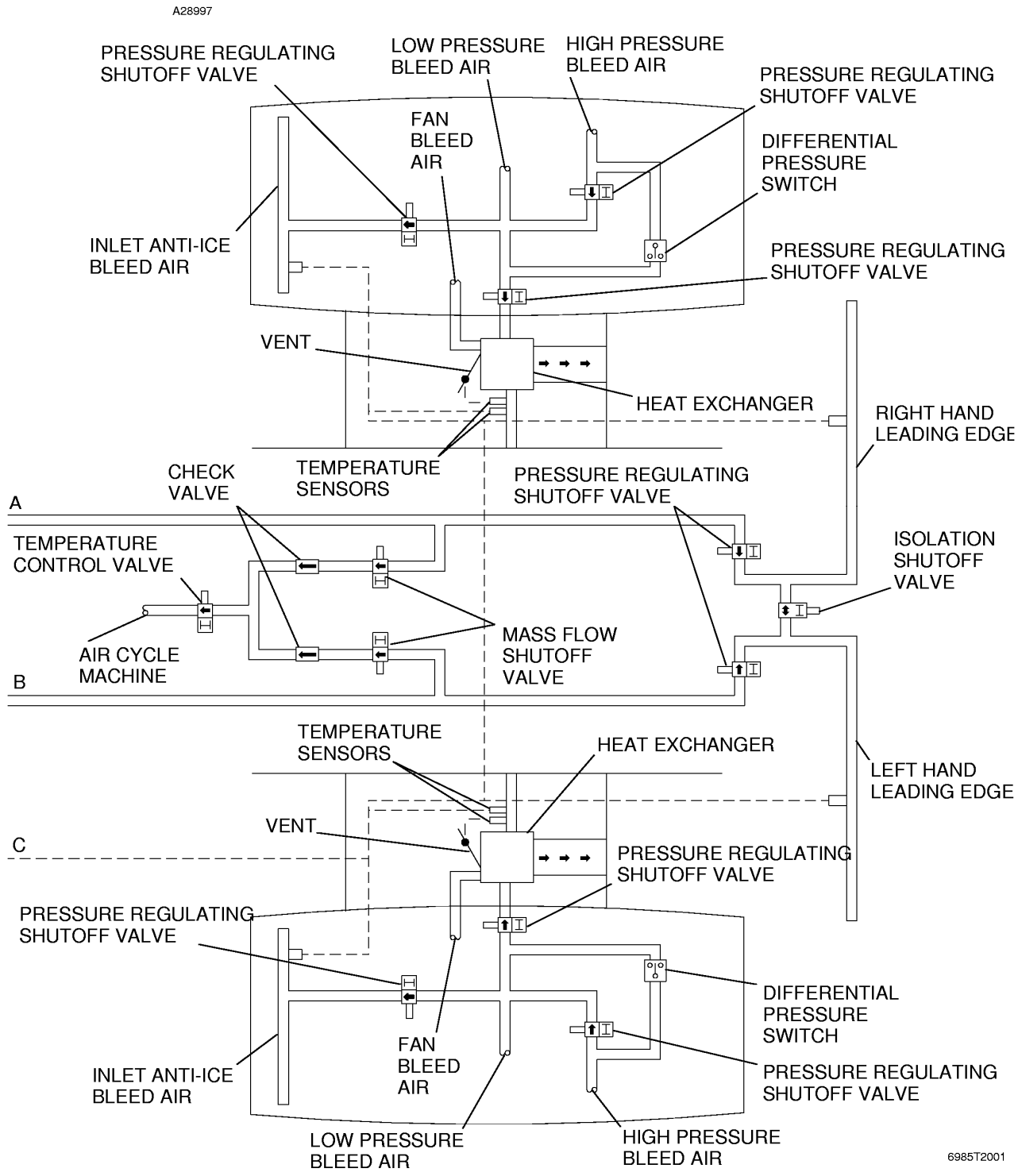

Figure 2-25 (Sheet 2)

HORIZONTAL STABILIZER ANTI-ICE

Anti-ice air to the horizontal stabilizer comes from the bleed air duct system. The bleed air is sprayed onto the inside surface of the horizontal stabilizer leading edge from a piccolo tube. Two pressure regulating shutoff valves, one for the left side of the stabilizer and one for the right, control the air individually. Check valves built into the pressure regulating shutoff valves prevent cross flow from the left engine to the right engine and vice versa. Selecting the Anti-Ice ENGINE/STAB L and R switches ON open the left and right horizontal stabilizer anti-ice pressure regulating shutoff valves.

A cross flow valve is provided so the bleed air can be provided to both horizontal stabilizers from either engine. The horizontal stab cross flow valve is actuated from the Anti-Ice WING/STAB XFLOW switch on the anti-ice tilt panel. Check valves located in the horizontal stabilizer anti-ice pressure regulating shutoff valves prevent bleed air from the right system from entering the left system and vice versa. This cross flow valve is normally closed and thus closes with a loss of electrical power.

Crew Alerting System (CAS) messages are used to monitor the status of the stabilizer anti-ice system. Sensors installed on the horizontal stabilizer leading edge skin monitor the horizontal stabilizer performance and drive the CAS messages. An amber STAB ANTI-ICE COLD L-R message will be displayed in flight if the stabilizer anti-ice is not up to the required temperature after the time delay has expired. On the ground, the cyan STAB ANTI-ICE COLD L-R CAS message will display immediately after selecting the respective Anti-Ice ENGINE/STAB L or R switch ON until the system passes pre-flight system check and the respective surface has heated to a safe temperature for takeoff. If an amber STAB ANTI-ICE O'TEMP L-R CAS message is displayed, the stab anti-ice valve will automatically close, if it is functioning normally, until the over-temperature has cleared. This message and automatic protection are active at all times.

The stabilizer bleed air leak detection system can also affect the operation of this system in the event of a leak. Refer to Bleed Air System, this section.

PRE-FLIGHT SYSTEM CHECK

Prior to Flight Into Known Icing, a ground preflight check of the Engine, Wing and Stabilizer anti-ice protection systems is required per AFM procedures. This preflight check ensures the systems are operating prior to operations in icing conditions. The procedure is to set both engines at 70 to 75% N_2 then select the Anti-Ice ENGINE/STAB L and R and WING L and R switches ON. Immediately after selecting these switches ON while on the ground, the cyan ENG ANTI-ICE COLD L-R, INBD WING ANTI-ICE COLD L-R, WING ANTI-ICE COLD L-R and STAB ANTI-ICE COLD L-R CAS messages will be displayed on EICAS. The bleed air monitor boards monitor the respective RTDs for each of these leading edge surfaces for 2 minutes. If during that time period the sensor detects the RTD for the inboard wing, wing, or stabilizer anti?ice system has increased in temperature by 10°C (18°F) and is above the undertemperature set point, the cyan COLD CAS message will extinguish. Similarly for the engine anti?ice system if during that time period the sensor detects the RTD has increased by 40°C (72°F) the cyan ENG ANTI-ICE COLD L-R CAS message will extinguish. The bleed air monitor board will latch the successful completion of this preflight check until power is cycled to the bleed air monitor board or until the squat switches cycle into the air mode.

This allows the crew to only run and pass this check once per flight. If anti?ice is selected on again after passing this preflight check no message will be displayed if the leading edge surfaces are above their respective cold set point. If the sensor detects the system has warmed by 10°C (18°F) for the inboard wing, wing, and stab or 40°C (72°F) for the engine inlet, but the temperature is still below the respective under temperature set point the ANTI-ICE COLD CAS message will change from cyan to amber for the appropriate surface until the system has reached the safe temperature. If the bleed air monitor detects that the system has not warmed by 10°C (18°F) for the inboard wing, wing, and stab or 40 °C (72°F) for the engine inlet in the 2 minute timeframe, the cyan ENG ANTI-ICE COLD L-R message will change to amber 2.5 minutes after switch selection. This is intended to indicate a failure somewhere within the indicated anti-ice system.

ICE DETECTION

Two windshield ice detection lights are mounted on the forward glare shield and are aimed at the windshield. A red light is reflected onto the windshield when ice begins to form. The red lights are not visible to the crew when the windshield is clear of ice. The windshield ice detection lights are powered on any time the instrument lights DAY/NIGHT DIM switch is ON.

Wing inspection lights are provided to illuminate the outboard portion of the wing leading edge, allowing the pilot to visually inspect for the formation of ice. The wing inspection lights are turned on by the Anti-Ice WING INSP LTS switch located on the anti-ice tilt panel. The wing inspection light has a ground adjustable gimbal fixture for precise aiming of the cone of illumination.

WINDSHIELD RAIN REMOVAL

A two-speed electric windshield rain removal fan is mounted in the nose avionics bay. The Anti-Ice WS FAN switch on the anti-ice tilt panel controls the fan. It normally runs at low speed, functioning as a cooling fan for the nose avionics bay. When the W/S FAN switch is selected ON, it runs at high speed to direct high velocity air onto both windshields to aid in clearing rain. The system is primarily for ground use, but does provide a small increase in rain removal in flight. The primary rain removal in flight is caused by the natural action of the treated windshield surface and the windshield shape. If visibility deteriorates on a part of the windshield, it may be that the treated surface has deteriorated. The surface can be re-treated and restored to its original condition.

WINDSHIELD ANTI-ICE

The left and right windshields and the left and right forward cockpit side windows are AC electrically heated; however, 28 VDC powers the windshield heat controller. Windshield anti-ice automatically comes on with engine power up. Windshield anti-ice improves cockpit comfort at high altitude and is required for windshield defog.

The left and right windshields each have three heating element areas. The left engine-driven alternator supplies power to the left windshield outboard and center section, the right windshield inboard section and the right side window. The right alternator supplies power to the opposite sections.

The windshield anti-ice is monitored by the amber WINDSHIELD HEAT INOP L-R and WINDSHIELD O'TEMP L-R CAS messages and the cyan AC BEARING L-R CAS message. The amber WINDSHIELD HEAT INOP CAS message indicates a fault or failure of the controller to supply power to the windshield. The amber WINDSHIELD O'TEMP CAS message indicates that the controller has detected an overtemperature condition, which automatically shuts the affected windshield off until the overtemperature condition clears. The cyan AC BEARING L-R CAS message indicates that the alternator bearing has approximately 20 hours of life remaining.

The windshield heat controllers are not on the emergency bus and therefore windshield anti-ice and windshield defog are not operable in emergency power mode.

Self-test of the temperature monitor system is normally accomplished before engine start by selecting the W/S TEMP position on the rotary test switch.

The pressurization system in the Citation Sovereign is designed to provide cabin pressure altitude to make sure flight crew and passenger comfort is maintained.