CHAPTER 10
ICE AND RAIN PROTECTION

INTRODUCTION

This chapter describes the ice and rain protection systems for the Citation Mustang. Anti-icing is provided for the engine inlets, instrument external sensors, and windshields. Deicing is provided for the wings as well as the horizontal and vertical stabilizers. Rain protection is also provided for the windshield.

GENERAL

Flight into known icing is the intentional flight into icing conditions that are known to exist by either visual observation or pilot weather report information. Icing conditions exist any time the indicated ram air temperature (RAT) is +10°C or below, and visible moisture in any form is present.

Engine anti-ice should be selected ON anytime the indicated ram RAT is +10°C or below, and visible moisture in any form is present. WING/STAB DEICE should be selected as soon as ice is observed to accrue anywhere on the airplane. If ice remains on the airplane during approach and landing, maximum flap extension is limited to the TO/APR position.

Ice accumulations significantly alter the shape of airfoils and increase the weight of the airplane. Flight with ice accumulated on

the airplane will increase stall speeds and alter the speeds for optimum performance. Flight at high angle-of-attack (low airspeed) can result in ice building on the underside of the wings and the horizontal stabilizer aft of areas protected by deice boots. Minimum sustained airspeed for flight in icing conditions (except approach and landing) is 160 KIAS. Prolonged flight with the flaps and/or landing gear extended is not permitted except as required for approach and landing. Use of Flaps LAND (30°) is prohibited when any ice is observed adhering to the outside of the airplane. Trace or light amounts of icing on the horizontal stabilizer can significantly alter airfoil characteristics which will affect stability and control of the airplane.

NOTE

With residual ice on the airplane, stall characteristics are degraded and stall speeds are increased.

Freezing rain and clear ice will be deposited in layers over the entire surface of the airplane and can "run back" over control surfaces before freezing. Rime ice is an opaque, granular, and rough deposit of ice that usually forms on the leading edges of wings, tail surfaces, pylons, engine inlets, and antennas, etc. Flight crews are to make sure that the airplane is free from ice prior to dispatch.

The Mustang uses conventional methods of ice protection. The engine inlets are anti-iced using engine bleed air. The wing as well as the horizontal and vertical stabilizer leading edges are protected using pneumatic deice boots. Electrical power protects the windshield, pitot probes, static ports, stall warning vane, and engine T2 probes. A passive rain repellent coating on the windshield provides clear vision in precipitation conditions. An overview of these locations is in Figure 10-1.

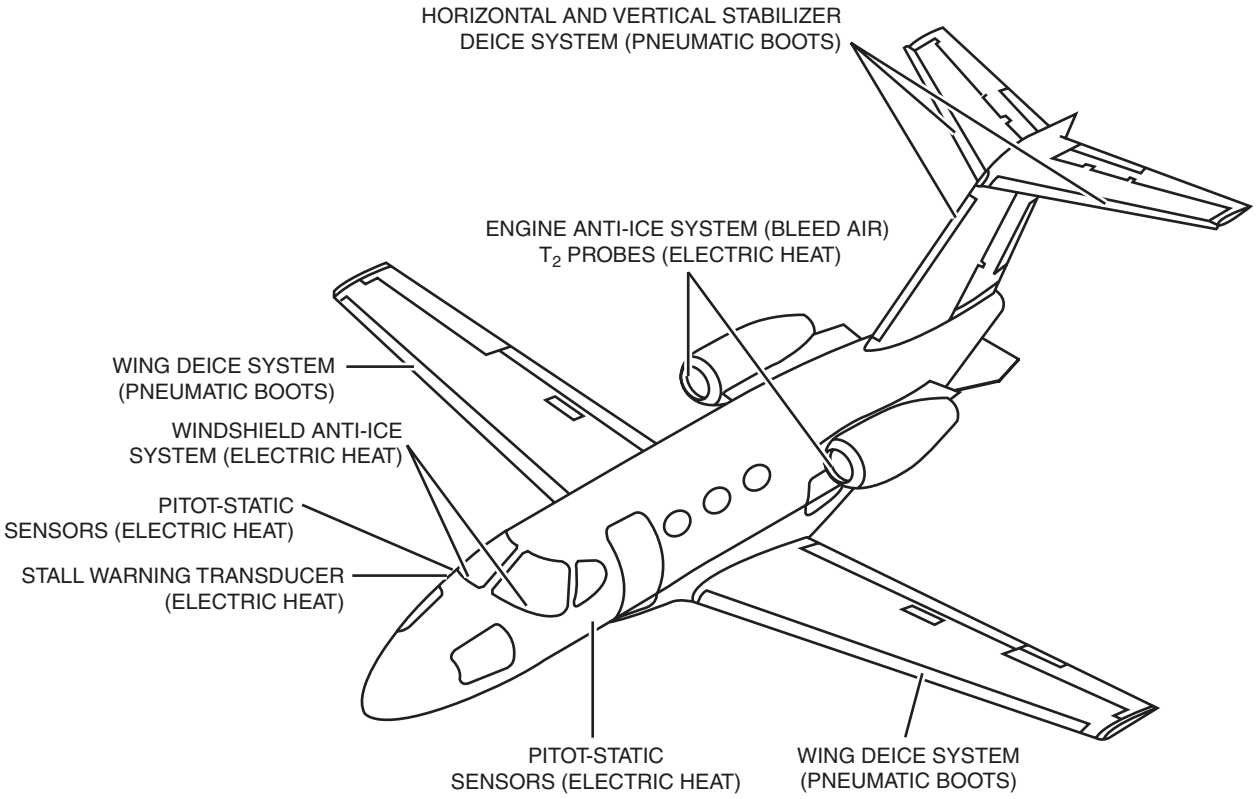

Figure 10-1. Citation Mustang Ice-Protection Systems

Each engine has two bleed-air ports: one inboard and one outboard. The inboard port provides bleed air for interior air conditioning and pressurization. The outboard port provides bleed air for engine inlet anti-ice and for inflating the deice boots. During single-engine operation, check valves in the supply lines from each engine prevent bleed air from one engine back-flowing to the opposite engine.

The ice protection system is controlled by green-capped switches on the pilot tilt panel, which is to the left of the LANDING GEAR handle (Figure 10-2). The status of ice protection systems is displayed by messages on the crew alerting system (CAS).

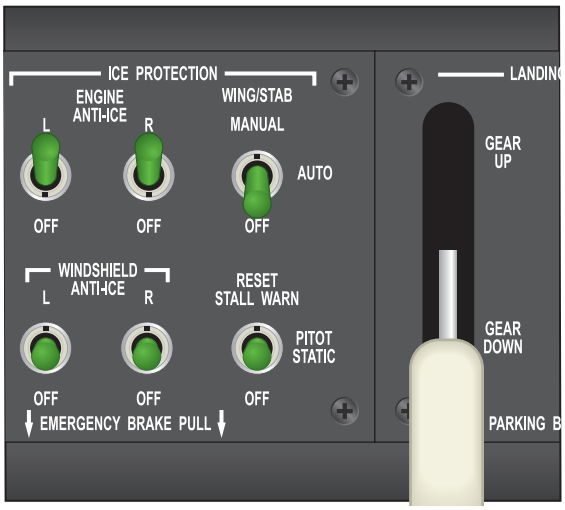

Figure 10-2. Ice-Protection Switches

ENGINE INLETS

DESCRIPTION

Each engine inlet and the inlet of the generator-cooling scoop is heated by regulated engine bleed air. Temperature of the bleed air is directly related to throttle position. Spent bleed air exits via a vent in the bottom of the inlet. This vent is inspected during preflight.

NOTE

There is no crossfeed between engines for inlet heating. If an engine fails, its inlet is no longer heated.

DC power is provided through an L or R A/I circuit breaker on its respective side ELE #2 bus. If DC power fails, the engine anti-ice valves automatically open, allowing hot air into the nacelle leading edges.

COMPONENTS

Engine Anti-Ice Shutoff Valves

The hot bleed air flows into each engine inlet through the engine anti-ice pressure-regulating shutoff valve (PRSOV) (Figure 10-3). When the valve energizes closed, the inlet is not anti-iced. The engine inlet PRSOVs are operated by the ENGINE ANTI-ICE switches and are electrically actuated.

In the absence of electrical power, the valves are pushed open by bleed-air pressure. When electrical power is applied, a solenoid powers the PRSOV closed. The PRSOVs control the air pressure downstream of the valve. These valves regulate the airflow of the engine anti-ice system.

Engine Inlet Anti-Ice Undertemperature Switches

The engine inlet undertemperature switches are inside the nacelle leading edge. These switches provide information through the monitoring circuits in the left and right ice protection system printed circuit boards (PCBs) to drive the white and amber ENG A/I COLD L or R messages.

Engine Inlet Anti-Ice Assembly

The engine inlet leading edge is hollow. Inside the leading edge, a circular piccolo tube is immediately behind the forward surface of the inlet. The hot bleed air enters the piccolo tube, sprays out of holes in the tube

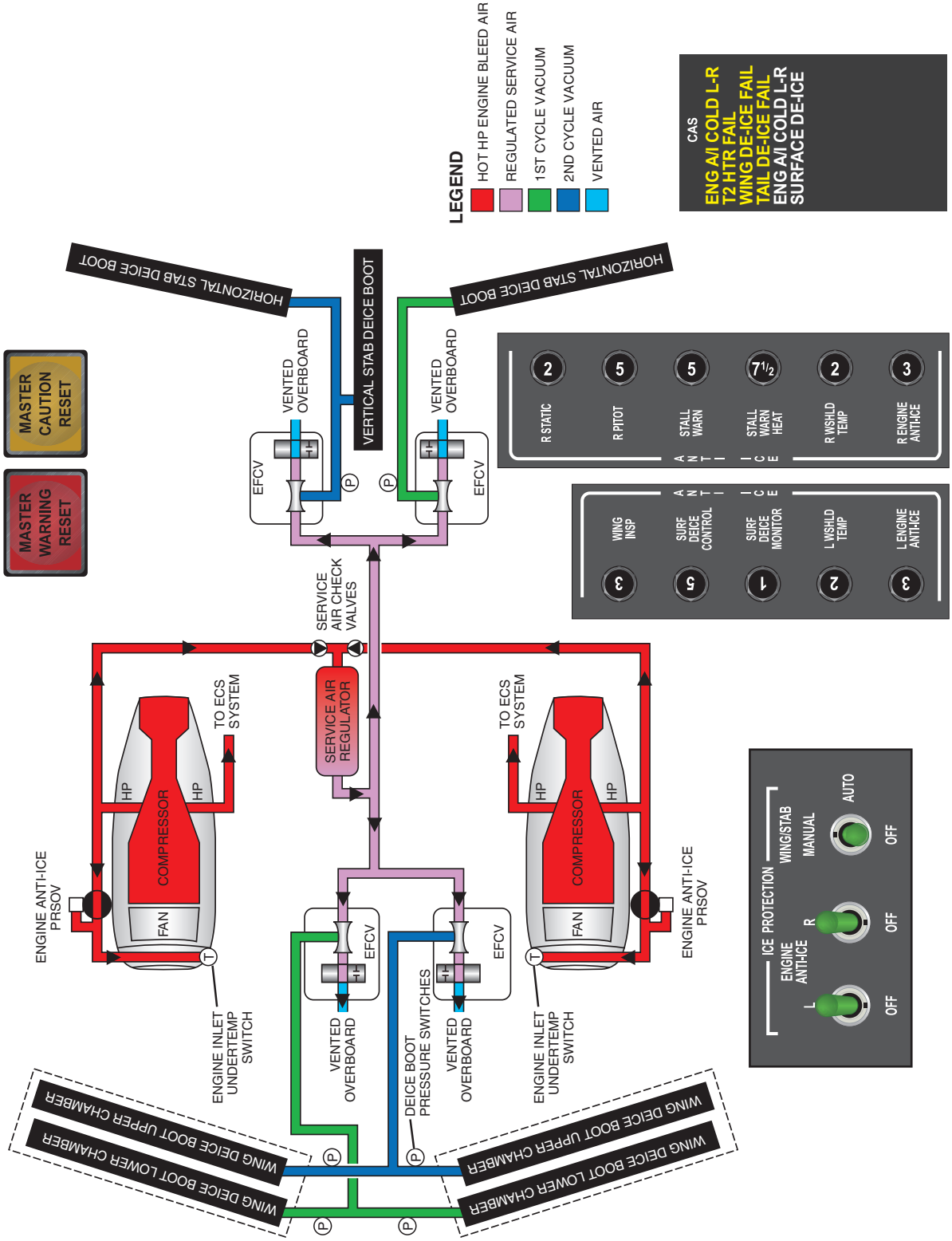

Figure 10-3. Bleed Air/Pneumatic Ice-Protection Systems

to circulate through the inlet leading edge, then exhausts overboard through a vent in the bottom of each inlet assembly.

CONTROLS AND INDICATIONS

Controls for the engine anti-ice system are on the pilot tilt panel with the other ICE PROTECTION controls (see Figure 10-2).

L and R ENGINE ANTI-ICE Switches

The L and R ENGINE ANTI-ICE switches control the flow of anti-icing bleed air to the engine inlet leading edges. Each ENGINE ANTI-ICE switch has two positions: L (or R) and OFF.

With the switches in the L or R (up) position, bleed air is directed to the engine inlet for each respective engine. In the OFF position, bleed air is blocked at the PRSOV.

With either ENGINE ANTI-ICE switch in the ON position, the undertemperature warning system is enabled for both engines.

Throttles

The temperature of the air supplied to the engine inlets is varied only by engine power settings.

ENG A/I COLD L or R Message

If the inlet leading edges do not receive adequate bleed air during use, the cold condition is annunciated by the respective ENG A/I COLD message. Undertemperature switches are inside the hollow engine inlet leading edges. After initial switch activation, the respective white ENG A/I COLD message appears while the undertemperature switches are below the temperature setpoint. As each inlet warms up, the respective ENG A/I COLD message disappears.

NOTE

At ambient temperatures above approximately 10°C (50°F), the white ENG A/I COLD messages may not display. In this case, satisfactory operation of the engine anti-ice system can be verified by a small momentary drop in N_2 and a slight increase in ITT when the respective ENG ANTI-ICE switch is turned ON.

If an engine inlet does not heat up within 2 minutes of initial switch activation or has cooled below a safe level, the respective *amber* ENG A/I COLD message appears.

OPERATION

When in icing conditions or when anticipating icing conditions, set the ENGINE ANTI-ICE switches to the L and R (up) positions. This deenergizes the shutoff valves, allowing hot bleed air to flow through and heat the engine.

When not in (or anticipating) icing conditions, set the ENGINE ANTI-ICE switches to the OFF positions. This energizes the shutoff valves closed, stopping the flow of bleed air to the engine inlets. This also increases engine efficiency and available power.

SURFACE DEICE (WING AND STABILIZERS)

DESCRIPTION

The Mustang uses pressure-regulated engine bleed air (via the service air system) to operate conventional pneumatic deicing boots. The full-span boots protect the wing, vertical, and horizontal stabilizer leading edges.

Service Air System

The pressurized air for inflating the pneumatic boots is supplied by the service air system. The service air is regulated to 20 psig by

a service air regulator (see Figure 10-3). The service air system is always active during operation of the aircraft. Bleed air from both engines is routed to the service air regulator through a check valve on each engine outboard bleed-air supply duct. The check valves keep bleed air from backflowing into either engine. The service air system provides regulated bleed air to the deice boot system. If one engine fails, the operating engine can supply enough bleed air to operate the wing, vertical, and horizontal stabilizer deice system.

Surface Deice System

The Mustang has a surface deice system on the wing, vertical, and horizontal stabilizers. This system uses regulated bleed air to inflate pneumatic boots to remove the ice. The boots, when inflated, normally crack and separate the ice from the leading edge of the protected surface, allowing aerodynamic forces to remove the ice. During normal operation, adequate pressure supplied to the boots is annunciated by the white SURFACE DEICE message. An amber WING or TAIL DE-ICE FAIL message appears in the CAS window if boot pressure is inadequate or boot inflation cycle is not normal.

The deice boot pressure switches are immediately downstream of each ejector flow control valve (EFCV).

The regulated service air is supplied to the wing and tail EFCVs, which supply either pressure or vacuum to the deice boots. There is one EFCV for each of the following four boot sets (see Figure 10-1):

- Wing upper deice boots (left and right)
- Wing lower deice boots (left and right)
- Left horizontal stabilizer deice boot
- Right horizontal deice boot and vertical stabilizer deice boots

The EFCVs are electrically powered closed to inflate the boots and spring-loaded open.

The surface deice system operates in one of three modes:

- Manual
- Automatic
- Inactive

COMPONENTS

Service Air Regulator

The service air regulator reduces the pressure of the engine bleed air to 20 psig from a variable of 25–200 psi. The pressure relief setting of the valve is 27 psig. If the service air regulator regulates too *low*, the failure is detected by the deice system monitors. If the service air regulator regulates too *high*, the pressure supplied to the boots is limited to 27 psig by the relief port of the valve.

Surface Deice Boots

The wing, horizontal stabilizer, and vertical tail are deiced by pneumatic boots controlled by the WING/STAB switch. The wing boots are separated into two independent pneumatic chambers: one for the upper surface and one for the lower surface. Each stabilizer boot has one pneumatic chamber. All boots have spanwise tube configurations.

Surface Deice Control Valves

The wing and stabilizer EFCVs are electrically controlled switching valves. When the deice system is turned off or not being inflated, vacuum is applied to the boots by the EFCVs. This is done by passing the supplied service air over a venturi in the valve and is then vented overboard. The other end of the venturi is connected to the boot and the flow created in the venturi creates the vacuum at the boot. When an inflation is triggered, a solenoid closes the EFCV vent and the service air then routes through the venturi to inflate the boot.

Surface Deice Pressure Switches

The boot pressure switches are immediately between the EFCV and their boots. There are four switches for the wing (two per side) and two switches for the vertical and horizontal stabilizers. The switches are set to close at 16 psig and open when the pressure decreases to below 10 psig. They provide information controlling the CAS messages for this system.

CONTROLS AND INDICATIONS

WING/STAB Switch

The control switch for the surface deice system is on the pilot side of the instrument panel with the other ICE PROTECTION controls (see Figure 10-2). The WING/STAB switch has three positions: OFF, AUTO and MANUAL.

In the OFF position, no power is supplied to the EFCVs and service air flows through the valves to create a vacuum that holds the boots deflated.

The AUTO position activates the deice control and monitor boards which run the 2-minute boot cycle.

The MANUAL position is spring-loaded and is active only while held in that position. When the switch is in the MANUAL position, power is supplied to the EFCVs to apply pressure to the boots. It also supplies a signal to the deice monitor board to check for adequate pressure supplied to the boots.

System Monitoring and Indications

Deice boot inflation is monitored by a series of pressure switches. One switch is provided for each deice boot chamber. The *right* ice protection system PCB monitors the pressure switches to verify the deice boots inflate when commanded by the *left* ice protection system PCB. If the deice boots fail to inflate, a discrete output is provided to the CAS to announce the failure.

SURFACE DE-ICE Message

In AUTO mode, a white SURFACE DE-ICE CAS message indicates when all pressure switches for the inflation sequence (lower wing/left tail or upper wing/right and vertical tail) are indicating deice boot inflation. In MANUAL mode, the white message displays only if all pressure switches indicate deice boot inflation. The pilot must verify the appearance of the white SURFACE DE-ICE message following activation of the surface deice system to protect against failures of the WING/STAB switch.

WING DE-ICE FAIL Message

The amber WING DE-ICE FAIL message appears if one or more of the pressure switches in the wing deice system does not receive adequate pressure.

This message also appears if pressure is sensed in the boot with the switch in the OFF position.

TAIL DE-ICE FAIL Message

The amber TAIL DE-ICE FAIL message appears when one or more of the pressure switches in the tail deice system does not receive adequate pressure.

This message also appears if pressure is sensed with the switch in the OFF position (i.e., boot is inflated when it should not be).

OPERATION

The wing and stabilizer deice system operates under electrical control when set with the WING/STAB switch in MANUAL or AUTO.

Manual Mode

During operation in manual mode, the pilot holds the WING/STAB switch the MANUAL position to inflate all of the deice boots. As long as the pilot holds the switch, the deice boots remain inflated. If all of the boot pressure switches receive adequate pressure, a white SURFACE DE-ICE message appears.

If one or more of the pressure switches does not receive adequate pressure, the appropriate amber WING DE-ICE FAIL and/or TAIL DE-ICE FAIL message appears.

Following release of the MANUAL switch, the spring-loaded switch immediately returns to the AUTO position, but the automatic cycle is delayed for 2 minutes before restarting the inflation sequence. This prevents the lower wing/left horizontal stabilizer deice boots from immediately inflating after the pilot releases the switch from the MANUAL position.

Automatic Mode

During automatic mode, the crew selects the WING/STAB switch to AUTO. This activates a timer, which causes the boots to inflate and deflate in a sequence that repeats every 2 minutes (Figure 10-4). The sequence repeats continuously until the OFF or MANUAL switch positions are selected. When selected OFF, the deice system completes the 2-minute inflation cycle to prevent any asymmetric ice accumulation. Figure 10-4 illustrates the automatic boot inflation cycle.

As in the manual mode, if all of the appropriate boot pressure switches receive adequate pressure, the white SURFACE DE-ICE message appears. If one or more of the pressure switches do not receive adequate pressure or if the boots do not inflate in the proper timed sequence, the appropriate amber WING DE-ICE FAIL and/or TAIL DE-ICE FAIL message appears.

Inactive

Whenever the boots are not being inflated, vacuum is applied to the boots to hold them down. This is true in automatic mode when not in the inflation period of the deice cycle. This is also true whenever the system is set to OFF.

WINDSHIELD ICE AND RAIN PROTECTION

The Mustang glass windshields include electric anti-icing/defogging and have a rain repellent applied. Individual sections of each windshield have different levels and sources of protection.

DESCRIPTION AND COMPONENTS

The Mustang uses 28-VDC electric power to provide windshield anti-ice and defog capability (Figure 10-5). Each windshield incorporates wire filament heaters in three separate zones:

- *Inner* zone—Provides both anti-ice and defog capability.
- *Middle* zone—Provides both anti-ice and defog capability.
- *Defog* zone—Provides defog capability *only*.

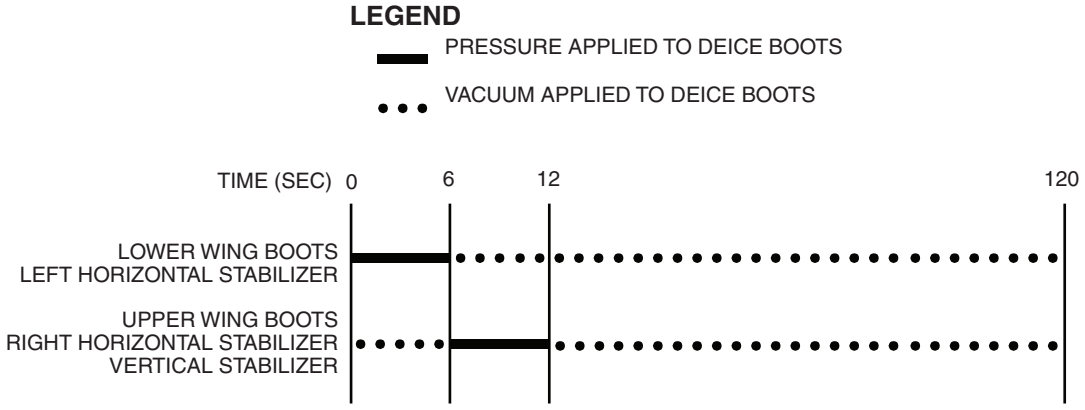

Figure 10-4. Wing Stabilizer Automatic Deice Cycle

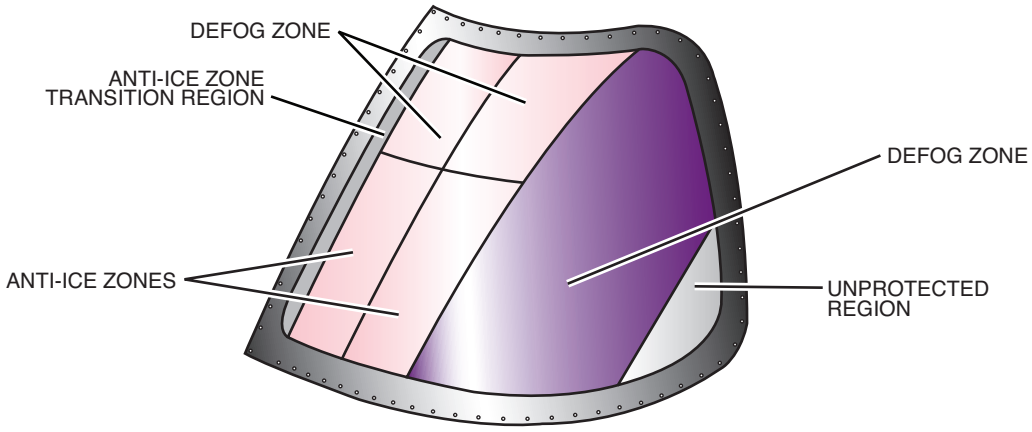

Figure 10-5. Windshield Anti-Ice/Defog Zones

NOTE

The upper region of each zone provides reduced heat. However, it is powered as part of the corresponding anti-ice or defog zones.

Each anti-ice zone has two temperature sensors (Figure 10-6). The primary sensor controls the temperature and monitors for overheats. If the primary sensor fails, the corresponding secondary sensor provides those functions.

Electrical power is distributed to each windshield zone by an anti-ice controller. Each controller receives DC power from two sources:

- Heating power comes to each controller directly from its respective feed bus through a 100-amp current limiter.
- Control and monitoring functions of each controller are powered from the respective feed bus through an extension bus, then through the corresponding L or R WSHLD TEMP circuit breaker (on the same side CB panel).

There are two separate windshield anti-ice controllers. Each controller can recognize a loss of generated DC power to the other controller; in that case, the controller that still has generated DC power automatically load sheds to only provide heat to one anti-ice panel on the left windshield. If both generators fail, windshield anti-ice is not available.

If one windshield anti-ice controller fails, but both generators continue to supply DC power, only the zones powered by the functioning controller continue to operate.

Rain Repellent

A passive rain repellent coating on the windshield external surface provides windshield rain protection. The coating requires periodic inspection and refurbishment.

CONTROLS AND INDICATIONS

WINDSHIELD ANTI-ICE Switches

The windshield heat is controlled by two toggle switches in the cockpit (one for each windshield panel) (Figure 10-7). The L and R WINDSHIELD ANTI-ICE switches have two positions:

- ANTI-ICE (up) applies power to both the defog *and* anti-ice zones.
- OFF removes power from the system.

CAS Messages

W/S O'HEAT Message

If the controller detects an overheat condition, power is removed from the overheated zone and a white W/S O'HEAT message appears in the

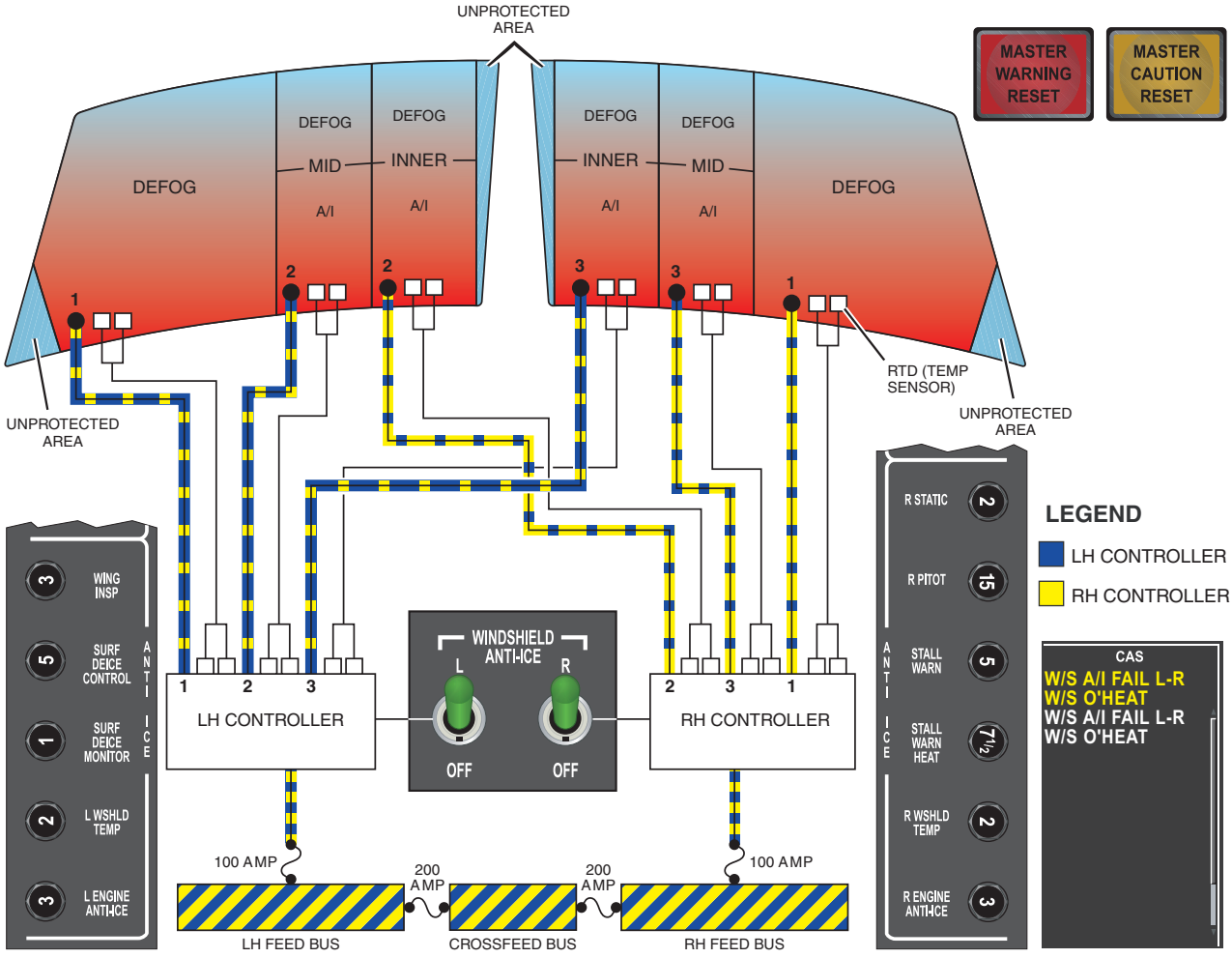

Figure 10-6. Windshield Anti-Ice Power Distribution

CAS window until the temperature falls to the acceptable range. If the overheat condition continues for more than 5 seconds, the message becomes amber.

W/S A/I FAIL Message

When an L or R WINDSHIELD switch is in the ANTI-ICE position and DC power is lost for that windshield, a white W/S A/I FAIL L (or R) message appears. If the power failure continues for more than 5 seconds, the message becomes amber.

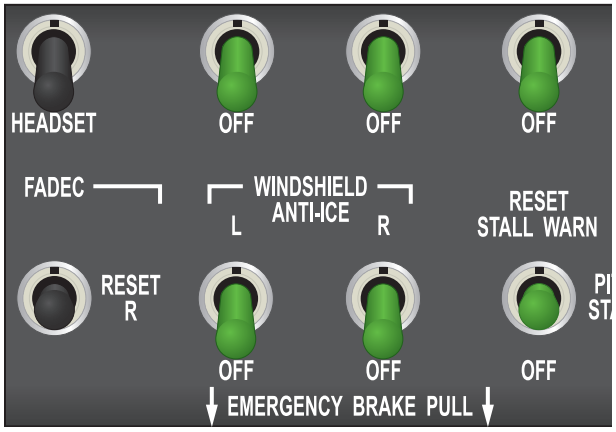

Figure 10-7. Windshield Anti-Ice Switches

OPERATION

When WINDSHIELD ANTI-ICE is selected, the windshield controllers provide a slow increase in temperature to avoid thermal shock to the windshield panels.

Each windshield controller monitors the windshield temperature sensors in the zones it controls. Using this information, it provides discrete outputs to the CAS for annunciation of controller failures or windshield overheats.

SENSOR ANTI-ICE SYSTEMS

DESCRIPTION AND COMPONENTS

Electric heat is provided to anti-ice the following sensors:

- Pitot probes
- Static ports
- Stall warning vane
- T2 probes

The heating element for each sensor is monitored by a current sensor to detect failures. Failure of any heating element is indicated on the CAS display.

CONTROLS AND INDICATIONS

Sensor Anti-Ice Switch

The pitot probes, static ports, and stall warning vane heaters are all controlled by a single switch on the ICE PROTECTION panel immediately left of the landing gear handle (see Figure 10-2). This switch has three positions:

- RESET STALL WARN—A momentary-contact position. Resets the stall warning to the normal stall airspeed. (Use RESET STALL WARN only when wings are verified free of ice).
- PITOT STATIC—Applies power to the sensors (both pitot probes, all four static ports, and the stall warning vane).
- OFF—Removes all power from those sensors.

ENGINE ANTI-ICE Switches

The T2 probes are electrically heated when their respective ENGINE ANTI-ICE switches are in the L or R position and the engine is running.

CAS Messages

The following amber CAS messages indicate failure of the heating circuits for the corresponding sensors:

- P/S HTR L-R—Pitot-static systems
- STALL WARN HTR—Stall-warning vane
- T2 HTR FAIL L-R—T2 probes

OPERATION

The pitot probe, static port, and stall warning vane heaters are powered by selection of the PITOT STATIC position on the sensor anti-ice switch.

In flight, the sensor anti-ice switch should be in the PITOT STATIC position, which heats the external sensors.

On ground, except in icing conditions or when ready for takeoff, the switch should normally be OFF to prevent overheating of the sensors and their heating elements.

During preflight, the switch may be set to PITOT STATIC for 30 seconds to verify the sensors are heating properly.

CAUTION

Limit ground operation of pitot-static heat to 2 minutes to preclude damage to the pitot-static and stall warning heaters.

Stall-Warning System Mode

When surface deice is enabled at any time (the WING/STAB switch is selected to MANUAL or AUTO), the stall-warning system changes its mode to a higher airspeed, and does not reset when surface deice is switched OFF. The system remains at this ice-contamination airspeed mode setting until the end of the flight or until RESET STALL WARN is selected.

Selecting RESET STALL WARN on the PITOT STATIC switch overrides the automatic ice-contamination setting, and returns stall-warning mode to the normal stalling airspeed, if surface deice is selected OFF.

The white STALL WARN HI message indicates that the stall-warning system is operating on the ice-contamination airspeed mode. Refer to the "Landing Performance" ANTI-ICE-ON landing performance charts in the *Airplane Flight Manual (AFM.)*

EMERGENCY/ABNORMAL

For specific information on emergency/abnormal procedures, refer to the appropriate abbreviated checklists or the FAA-approved *AFM*.