CHAPTER 30 - ICE AND RAIN PROTECTION

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GENERAL

The ice and rain protection systems purpose is to provide a detection signal, prevent the aircraft from ice accretion in critical areas, eliminate any ice if it deposits, and wipe out rainwater from the windshield.

Ice and rain protection are possible by means of:

- ***Wing and Tail De-icing:*** eliminates ice from the protected surfaces by means of pneumatic boots.
- ***Air Inlet De-icing:*** eliminates ice from the engines air inlets by means of pneumatic boots.
- ***Pitot and A.O.A. Sensors Anti-icing:*** avoids ice accretion at sensors by means of electric heaters.
- ***Windshield Ice and Rain:*** a set of wipers and electric heaters protect the windshield.
- ***Propeller De-icing:*** eliminates ice from the propeller blades leading edges by means of electric mats.
- ***Ice Detection:*** alerts the crew members to the ice accretion at the detector.

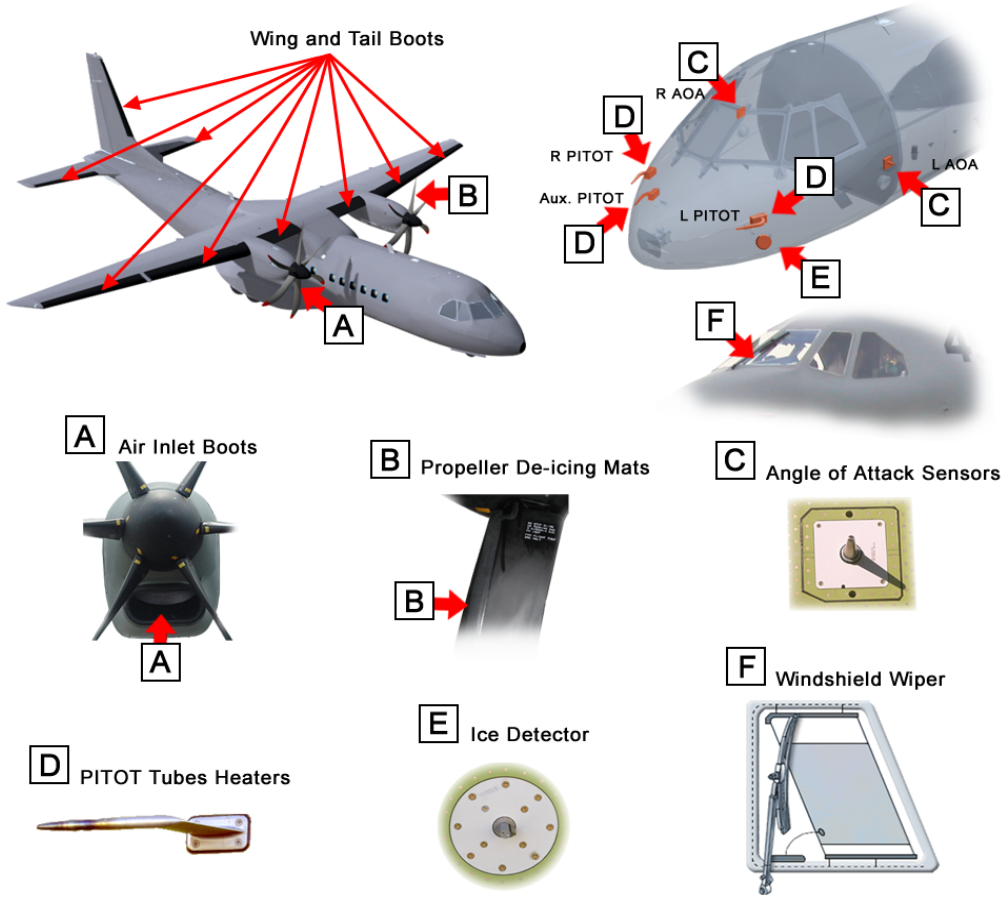


Figure 30-1 Ice and Rain Protection

WING AND TAIL DE-ICING

Its function is to break the ice on the leading edges, by intermittent inflation of elastic boots.

DESCRIPTION

The main components are:

- ***De-icing Boots:*** mounted along the entire wings leading edge, horizontal and vertical stabilizers are made up off layers of rubber-containing inflatable chambers.
- ***Shut off Valves (SOV):*** allow to cut off the bleed air supply in case of failure.
- ***Regulator Valves (PRV/RV):*** control the bleed air supply as required to inflate/deflate the boots, limit the maximum bleed air flow and prevent from excessive pressure.
- ***Electrical Heating Mats:*** protect the distributing valves from freezing.
- ***Distributor Valves (DV):*** each valve can control two different boots separately. They also can produce a vacuum, holding the boot against the leading edge when it is not inflated.
- ***Controller:*** manages the distributor valves, regulating the air supply to the de-icing boots.
- ***ICE PROTECTION Control Panel:*** located on the cockpit overhead panel.
- ***Water Separator:*** reduces the free water in the air, before supplying it to the boot.
- ***Pressure Switches:*** to indicate high or low pressure in the system.
- ***External Connection:*** allows external air to be supplied to the system for functional tests.

OPERATION

The air from each engine pneumatic system flows at first through a non-return valve and the SOV. When this SOV is closed, the pressurization system stops working in automatic mode. Downstream from the SOV, the PRV/RV adjusts the pressure. The output ducts from both regulator valves are interconnected to allow air to be supplied to both sides, in case of engine failure. Additionally, if a leakage or a PRV/RV failure causes excess or insufficient pressure, a set of pressure switches display the W&T D-ICE caution on the IEDS. After the water separators, the distributor valves apply pressure or suction to the related boots, according to the orders received from the controller. These valves are protected by heating mats to avoid from freezing. The mats come on when the engine air inlet de-icing system is turned on. The controller also monitors the system operation. In case of a controller failure, distributor valves failure or air leakage, the controller displays the W&T DEGRD caution on the IEDS.

The system operates in two modes:

- ***Automatic Modes (HVY ICE or LT ICE):*** the controller manages the distributor valves in the following sequence:
  1. Inflation of the outer boots for 6 seconds.
  2. Inflation of the central boots for 6 seconds.
  3. Inflation of the inner boots for 6 seconds.
  4. Inflation of the three tail boots for 6 seconds.
  5. Rest time of 36 seconds in HVY ICE mode, or 156 seconds in LT ICE mode.
- ***Manual Mode (MAN):*** each group of boots is operated by means of the OW (outer wing), CTR (centre wing), INR (inner wing) and TAIL buttons.

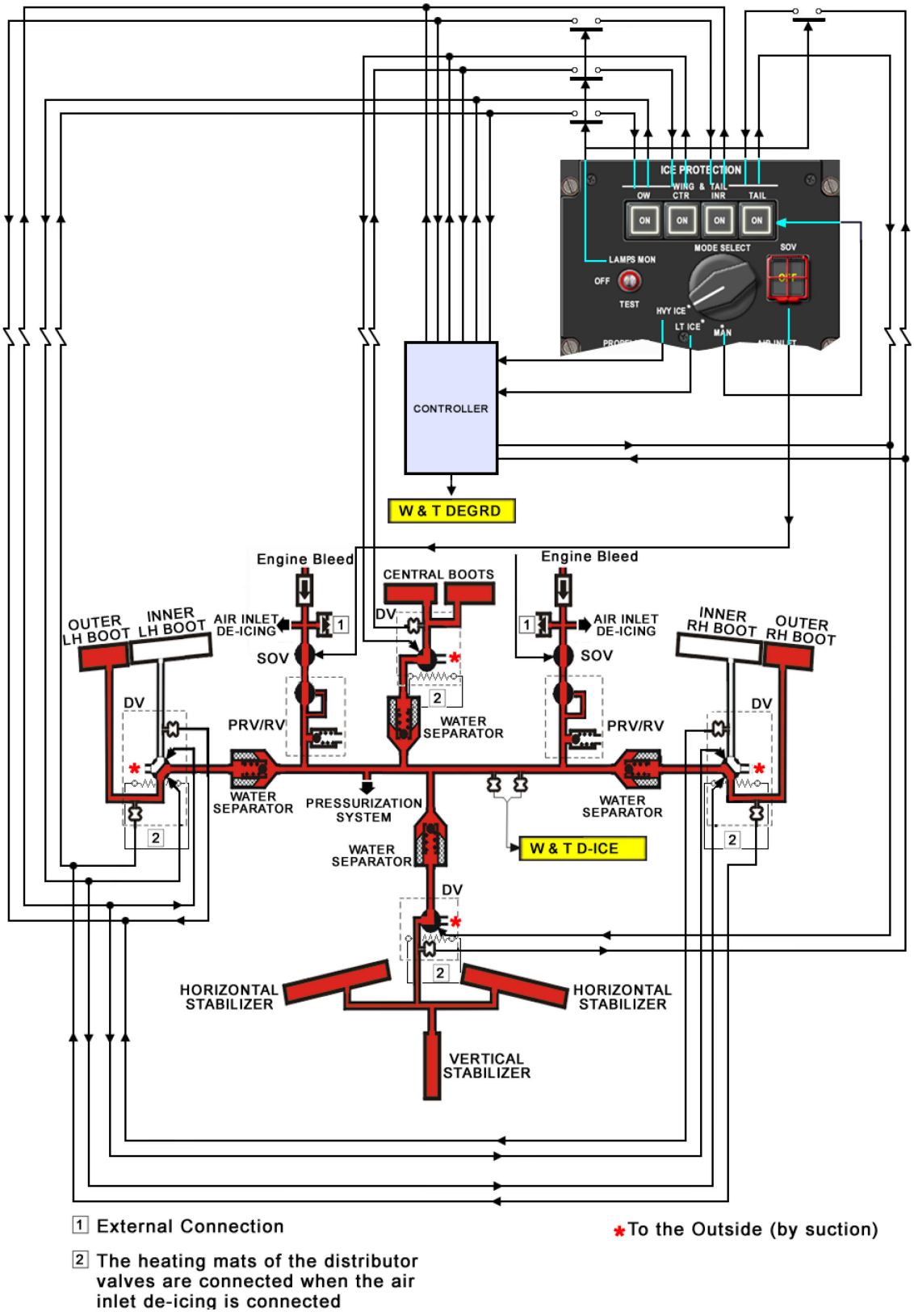


Figure 30-2 Wing and Tail De-Icing - Architecture

CONTROLS AND INDICATORS

(1) De-icing Supervision Switch:

- *LAMPS MON:* the boots operation is monitored by the manual de-icing buttons.
- *TEST (momentarily):* checks the lamps in the manual de-icing buttons.

(2) WING & TAIL De-Icing Pushbuttons (OW, CTR, INR, TAIL):

- *Pressed and held:* the related distribution valve opens and the associated boots inflate. Releasing the button, deflates the associated boots. MODE SELECT de-icing selector must be set in the MAN position.
- *ON light on:* pressure has reached the boot. The de-icing supervision switch must be in the LAMPS MON position, whether in manual or automatic mode.

(3) SOV Pushbutton (under guard):

- *Pressed (OFF light on):* SOV valves are closed.

(4) De-icing MODE SELECT Selector:

- *MAN:* operation with the manual de-icing buttons is allowed.
- *LT ICE:* the rest period after all boots operation is 156 seconds (total cycle 180 seconds).
- *HVY ICE:* the rest period after all boots operation is 36 seconds (total cycle 60 seconds).

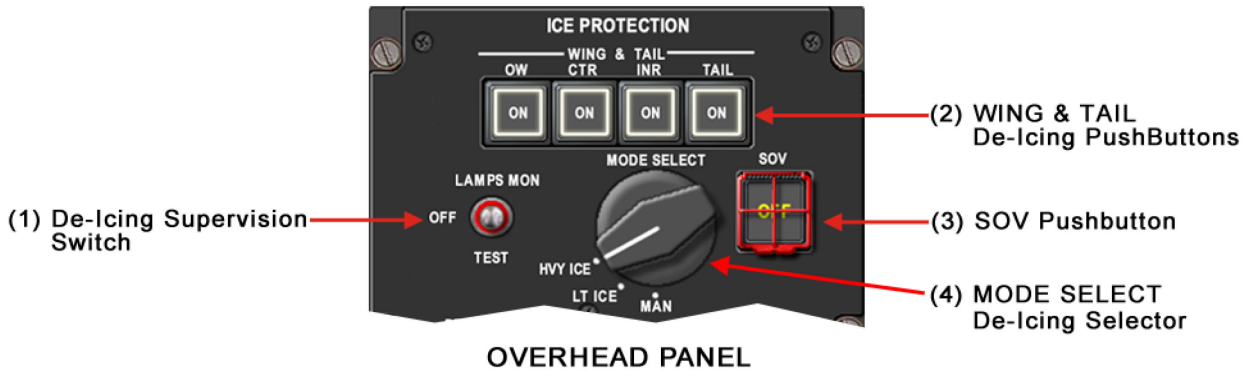


Figure 30-3 Wing and Tail De-icing - Controls and Indicators

AIR INLET DE-ICING

Its function is to break the ice on the engines air inlets, by intermittent inflation of elastic boots.

DESCRIPTION

The main components are:

- ***De-icing Boots:*** two pneumatic boots per engine (Lip boot and Bypass boot), built in to each engine air inlet.
- ***Regulator Valves (PRV/RV):*** control the bleed air supply as required to inflate/deflate the boots, limit the maximum bleed air flow and prevent from excessive pressure.
- ***Water Separator:*** reduces the free water in the air, before supplying it to the boot.
- ***Ejector Valves (EV):*** control the boots. They also can produce vacuum, holding the boot against the inner surface of the air inlet.
- ***Controllers:*** manages the ejector valves. There are two controllers, one for each engine air inlet.
- ***ICE PROTECTION Control Panel:*** located on the cockpit overhead panel, enables system management and monitoring.
- ***Heater Drain Mast:*** there is a drain mast on the lower cowl of each engine. In order to avoid ice formation inside it, the drain mast has a heater.

Figure 30-4 Air Inlet De-icing - Components

OPERATION

Each air inlet de-icing system receives unregulated compressed air from the related engine and it flows through the regulator valve (PRV/RV), which adjusts its pressure. Downstream from the PRV/RV, there are a water separator and an ejector valve, which applies pressure or suction to the boots according to the orders received from the controller.

During normal operation, the boots are inflated for 6 seconds and deflated for 54 seconds.

If there is a failure on either an ejector valve or one of the controllers, the FAIL light will come on the related button and the 1,2 E/D-ICE caution will be displayed on the IEDS.

Some pieces of the broke ice or water can remain inside the air inlet, so a drain mast is placed in that position to evacuate them. To prevent the blockage of this mast, it is heated by means of an electrical heater.

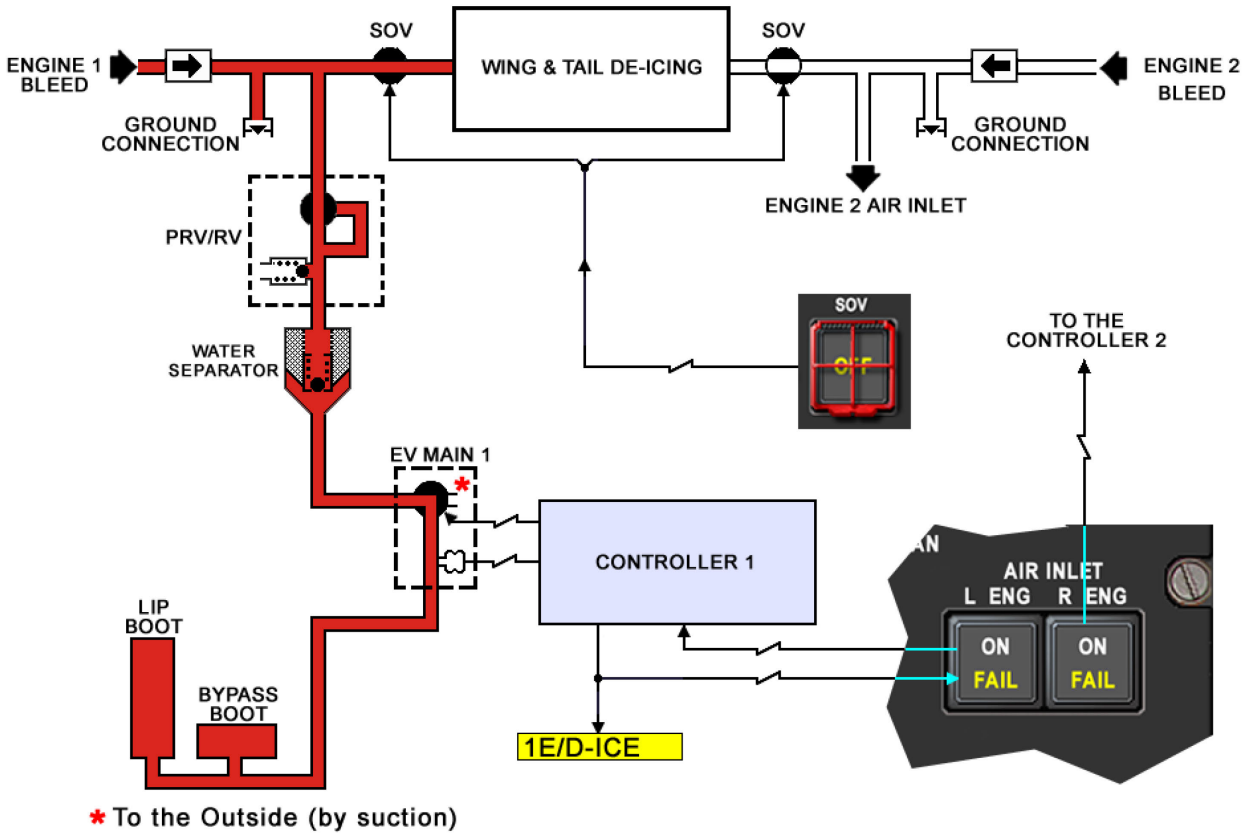
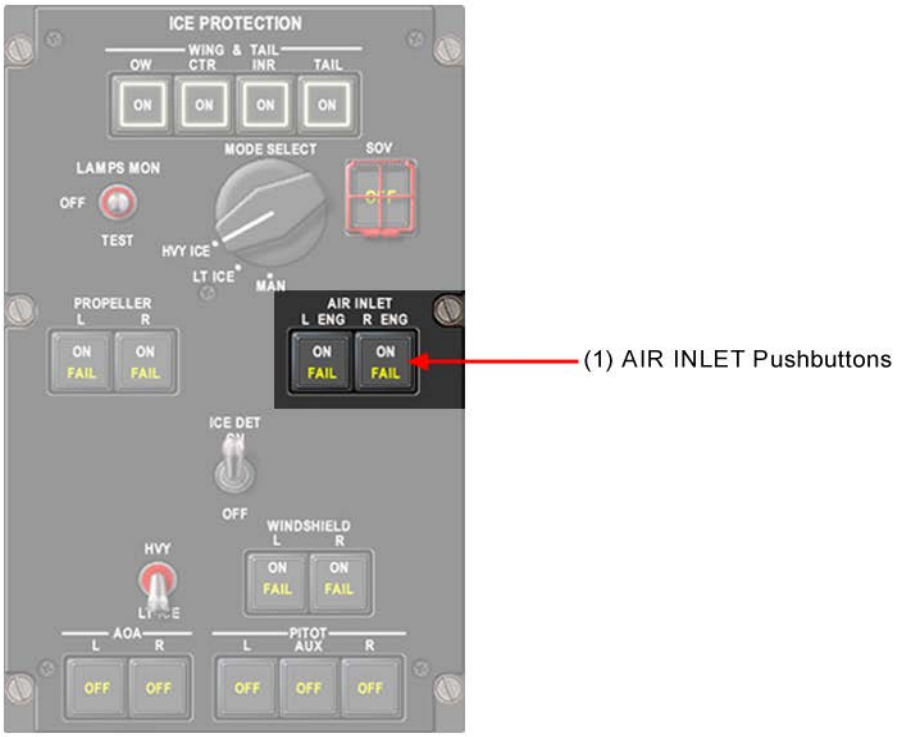


Figure 30-5 Air Inlet De-icing

CONTROLS AND INDICATORS

(1) AIR INLET Pushbuttons:

- *Pressed (ON light on):* air inlet boots are operative. The heater drain mast and the heating mats on the distributor valves (DV) of the wing and tail de-icing system are also connected.
- *FAIL (amber) light on:* failure in the related de-icing system.



OVERHEAD PANEL

Figure 30-6 Air Inlet De-icing - Controls and Indicators

PITOT AND A.O.A. SENSORS ANTI-ICING

Its function is to prevent from ice accretion on the air data sensors.

DESCRIPTION

The main components are:

– ***Heating elements:*** located in Pitot and static tubes (L, AUX, R) and angle of attack sensors (L, R), they prevent from ice accretion on their surfaces.

– ***ICE PROTECTION Control Panel:*** located on the cockpit overhead panel, enables system management and monitoring.

OPERATION

The heating elements are controlled with the AOA and PITOT anti-icing buttons.

If any of the heating elements in the pitot tubes fail, or any of the pitot heating systems is switched OFF, the related 1, 2, AUX PITOT caution will be displayed on the IEDS.

CONTROLS AND INDICATORS

(1) A.O.A. Anti-Icing Pushbuttons:

- *OFF (amber) light on:* heater for relevant AOA sensor is not energized.
- *Pressed (OFF light off):* related AOA heater is energized.

(2) PITOT Anti-Icing Pushbuttons:

- *OFF (amber) light on:* heater for relevant Pitot tube is not energized.
- *Pressed (OFF light off):* related Pitot tube heater is energized.

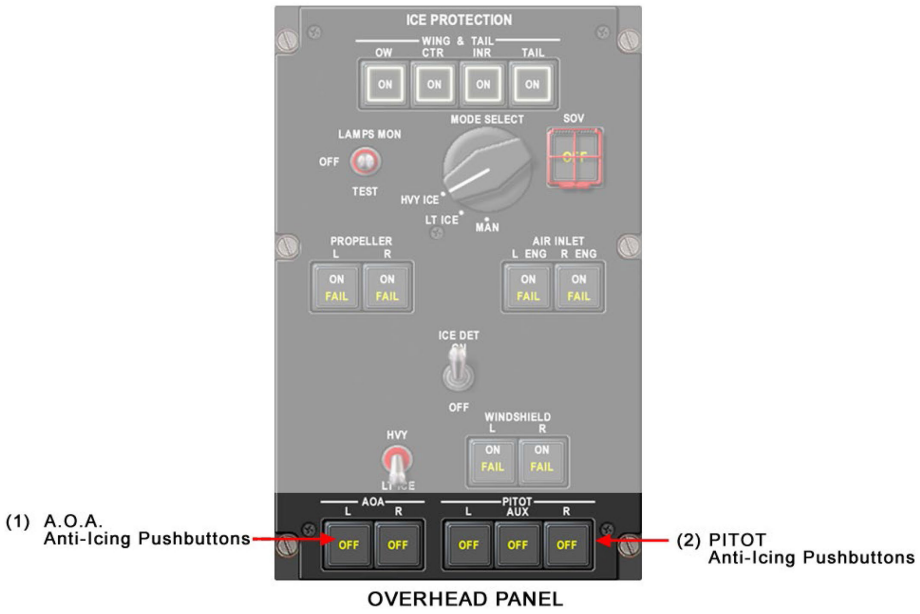


Figure 30-7 Pitot and A.O.A. Sensors Anti-Icing - Controls and Indicators

WINDSHIELD ICE AND RAIN PROTECTION

Its function is to avoid, in the windshield, internal misting as well as ice accretion and rainwater on its surface. If the windshield is heated, it also improves the glass impact strength at low temperatures.

DESCRIPTION

The main components are:

- ***Windshield Heating Elements:*** integrated in the windshield, each element heats up its side of the windshield.
- ***Temperature Regulators:*** control the windshield heating elements, aided by temperature sensors.
- ***ICE PROTECTION Control Panel:*** located on the cockpit, manages and monitors the windshield heating elements.
- ***Windshield Wiper:*** enables water to be wiped out from the windshield.
- ***WIPER Control Panels:*** located on C/M-1 and C/M-2 consoles, enables system management and monitoring.

OPERATION

When the windshield heating system is on, electricity is supplied to the temperature regulator. This regulator maintains the windshield temperature and prevents it from overheating. In the central windshield there is no protection against ice.

If one of the regulators fails, the FAIL light on the related WINDSHIELD anti-icing pushbutton will come on and the other regulator will take control on both sides. If both regulators fail, the WSHLD caution will be displayed on the IEDS.

NOTE

If windshield is turned on above 25º Celsius OAT, WSHLD caution could be displayed on IEDS.

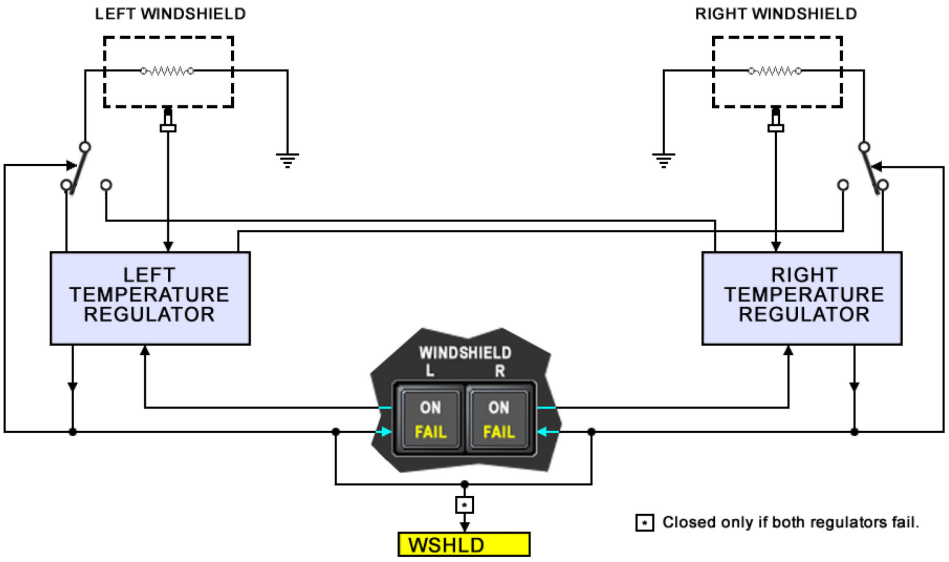


Figure 30-8 Windshield Anti-Icing Protection

Both wipers start operating when one of the WIPER selectors is set to the LOW or HIGH position. However, the system allows a different speed to be set on each (by setting one selector to the HIGH position and the other to LOW).

CAUTION

Wipers must never be used when the windshield is dry.

CONTROLS AND INDICATORS

(1) WIPER Selector:

- *PARK:* windshield wipers go to parking position (vertical). When released, it returns to OFF.
- *LOW:* low speed wipe.
- *HIGH:* high speed wipe.
- *OFF:* stops the wiper at the current position.

(2) WINDSHIELD Anti-icing Pushbuttons:

- *ON light on:* turns on the related windshield heating element.
- *FAIL (amber) light on:* failure in the related regulator.

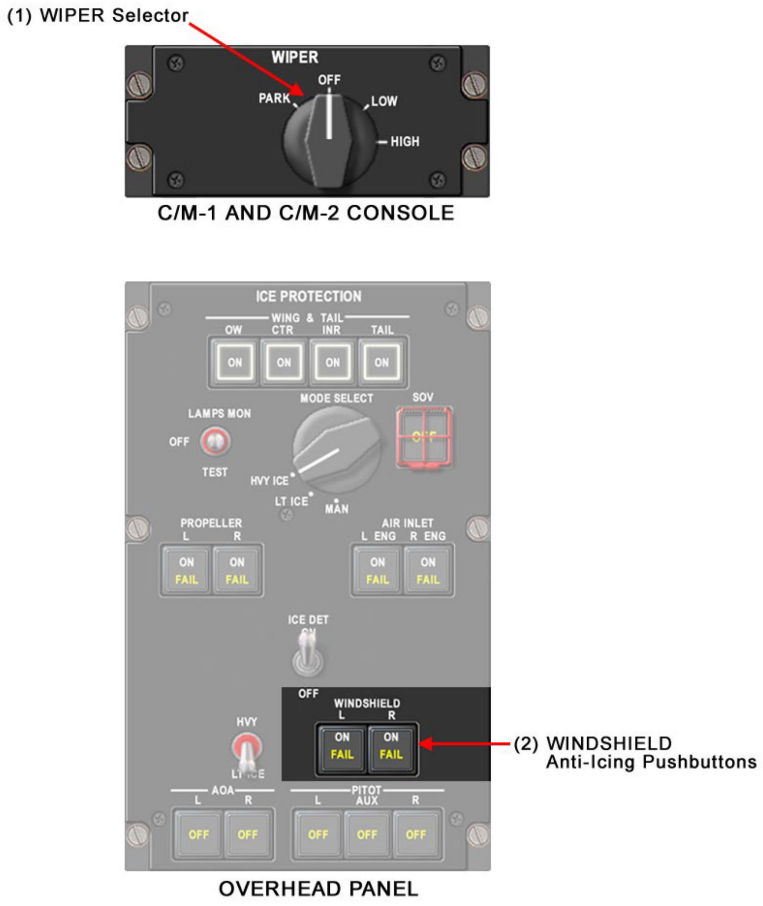


Figure 30-9 Windshield Ice and Rain Protection - Controls and Indicators

PROPELLERS DE-ICING

Its function is to avoid the excessive ice accretion on the propeller blades.

DESCRIPTION

Main components are:

- ***Heating Jackets:*** attached to the leading edge of the propeller blades and protect at least 60% of the leading edge of the propeller, closest to the hub.
- ***Timers***: two timers, one for each engine, supply electricity to the jackets and controls them.
- ***ICE PROTECTION Control Panel:*** located on the cockpit overhead panel, enables system management and monitoring.

OPERATION

When the system is connected, it starts a timing sequence which first powers the heating jackets on blades 1, 3 and 5 and then those on blades 2, 4 and 6 of each propeller.

It should be noted that when each system is set to on, the FAIL light on each button will come on briefly during the self-test sequence. The FAIL light must go out after five seconds and the ON light come on. This does not indicate a system failure.

The system has two possible modes of operation:

- *LT ICE:* for temperatures above -10ºC. The heating jackets come on for 10 seconds and stay off for 60 seconds.
- *HVY ICE:* for temperatures below -10ºC. The heating jackets come on for 20 seconds and stay off for 60 seconds.

The timer is powered with the DC generator and the heating jackets are powered with AC from its related alternator, so it is necessary Np≥70%. If one alternator fails, the related heating jackets will be inoperative. If one timer fails, the related heating jackets will be inoperative.

If there is a failure in one of the timers, or the electrical power supplied to the heating jackets is out of the operating limits (10% of rated value), the 1, 2 P/D-ICE caution is displayed on the IEDS. It also displayed, for 10 seconds, when the system is turned on.

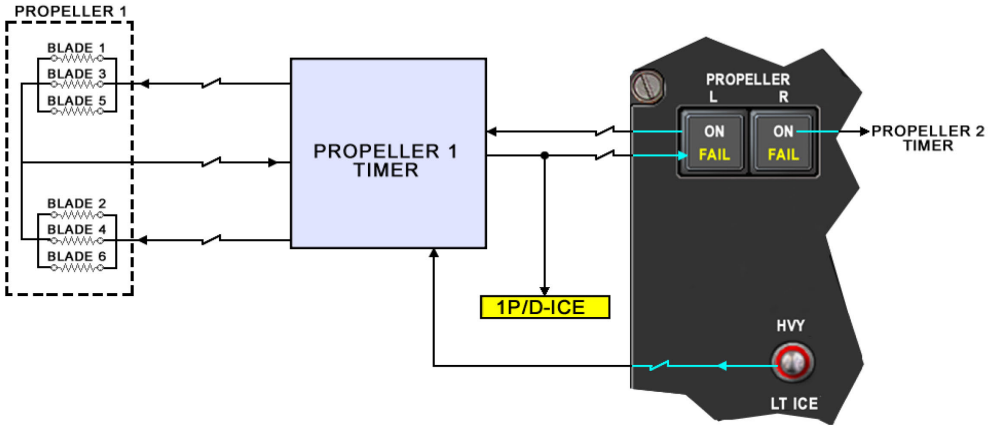


Figure 30-10 Propeller De-icing

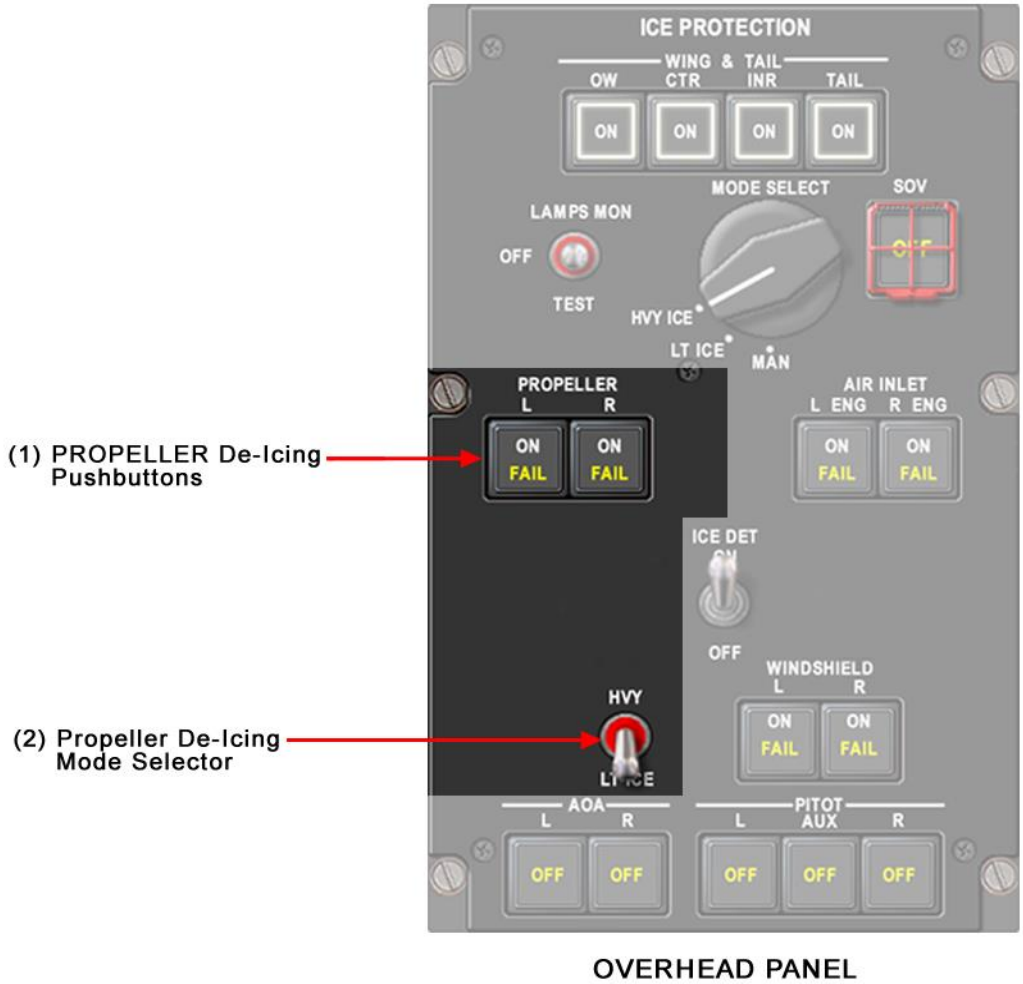
CONTROLS AND INDICATORS

(1) Propeller De-Icing Pushbuttons:

- *Pressed (ON light on):* the related propeller de-icing system is on.
- *FAIL (amber) light on:* there is a failure on the related propeller de-icing system. It also comes on, for 10 seconds, when the system is turned on.

(2) Propeller De-Icing Selector:

- *HVY:* the HVY ICE mode of operation is selected.
- *LT ICE:* the LT ICE mode of operation is selected.



OVERHEAD PANEL

Figure 30-11 Propeller De-icing - Controls and Indicators

ICE DETECTION

The system alerts the crew members to the possibility of icing conditions.

This is not a primary system, as ice detection at diverse areas of the aircraft is based on pilots direct visual inspection. This system is intended to help the pilots to identify ice accretion.

DESCRIPTION

The main components are:

– ***Ice Detector:*** located on the left side of the nose, near the pitot tube. It consists of a small electrically-powered rotating cylinder, with a blade close to its surface.

– ***ICE PROTECTION Control Panel:*** located at the cockpit overhead panel, enables system management and monitoring.

OPERATION

When the ICE DET switch is set to ON, power is supplied to the ice detector, and the cylinder turns. Under icing conditions, ice deposits on the cylinder surface interfering with the blade. When the friction on the ice detector cylinder increases, the ICE FORM Caution is displayed on the IEDS.

The ice detection system must be connected during flight, even in the absence of icing conditions.

CONTROLS AND INDICATORS

(1) ICE DET Switch:

- *ON:* ice detector is on.
- *OFF:* ice detector is off.

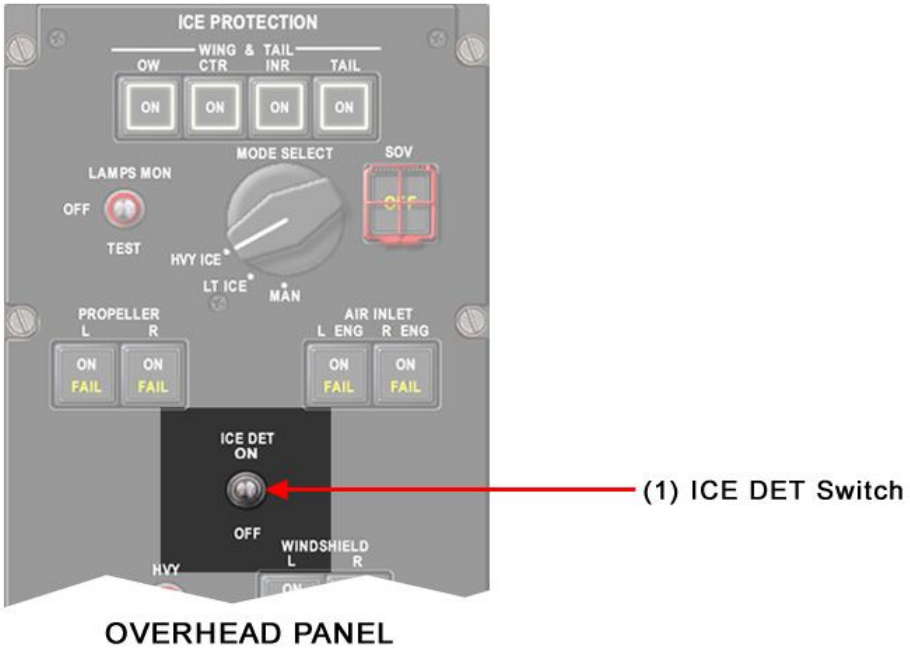


Figure 30-12 Ice Detection - Controls and Indicators

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