TECHSAVIATION
Training Center

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ICE AND RAIN PROTECTION - ATA 30-00

Ice and Rain Protection

Primary Ice Detection System

The Primary Ice Detection System (PIDS) identifies icing conditions. The PIDS sends icing data to hosted functions and applications in the Common Core System (CCS).

These ice and rain systems use the ice detection system data for automatic operation:

- Engine Anti-Ice (EAI)
- Wing Ice Protection System (WIPS)
- Cabin Air Compressor (CAC) Inlet Ice Protection System (CIPS).

Description

The PIDS has two probe assemblies, one on the left side and one on the right side of the airplane nose.

Each PIDS probe has these internal components:

- Heater
- Wet temperature sensor
- Dry temperature sensor
- Control and fault monitoring circuit cards.

The PIDS detectors also get air data from the Air Data Reference Function (ADRF), in the Flight Control Electronics (FCE).

The PIDS uses this data to detect icing conditions:

- Moisture
- Ground speed
- Air/ground data
- Angle of Attack (AOA)
- Ambient air temperature
- Total Air Temperature (TAT)
- Total air pressure (Pt)
- Static pressure (P0).

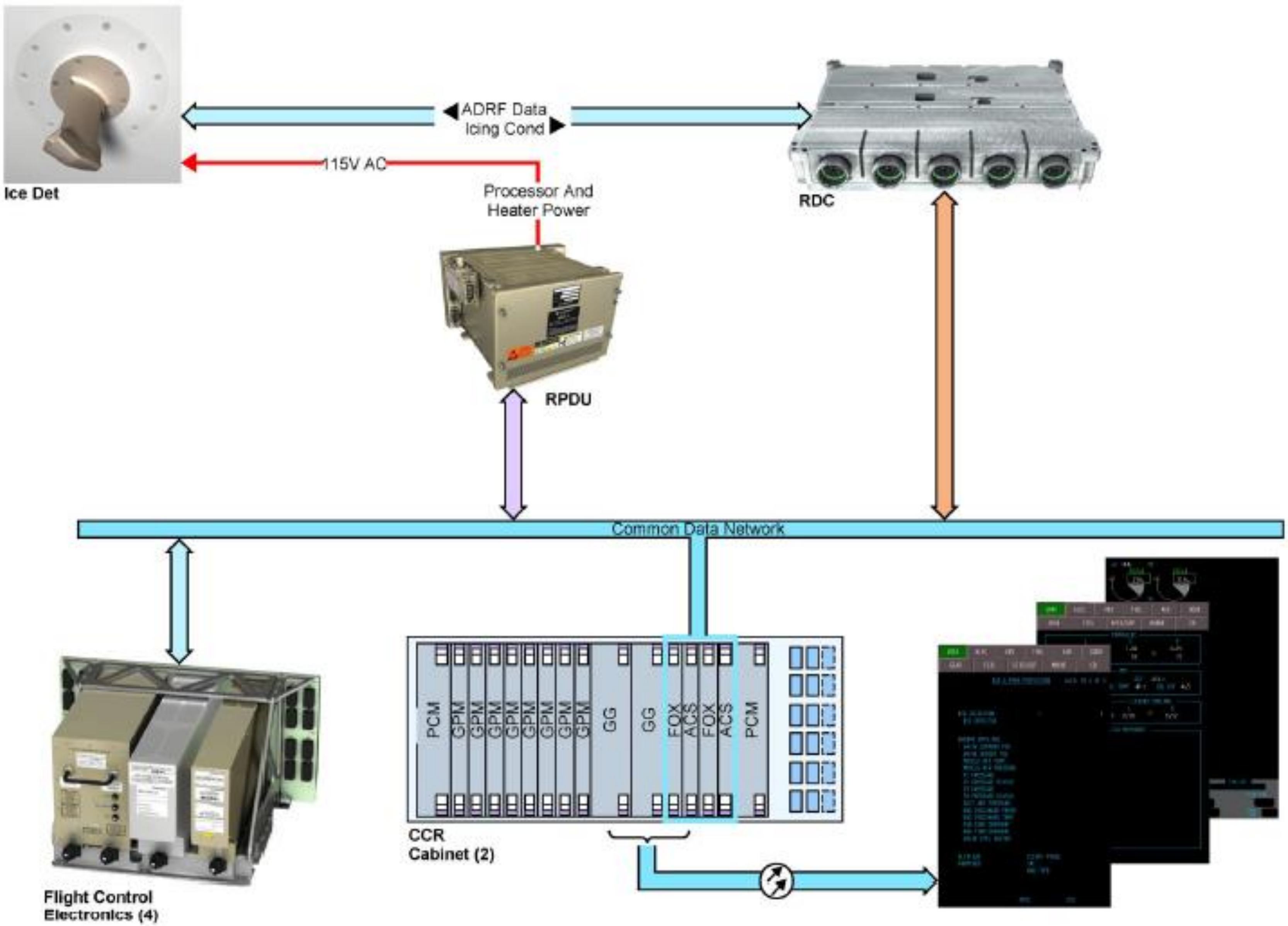
The two PIDS detectors are independent and redundant. The PIDS can operate with one detector inoperative.

The PIDS detector heater keeps ice from building up on the detector body.

Operation

The PIDS dry temperature sensor measures total air temperature. The PIDS uses the wet temperature sensor to measure the difference of the temperature of the air necessary to evaporate liquid moisture from the air, and ambient air temperature. The PIDS detector circuit card uses these two temperature references to detect current icing conditions.

The PIDS sends icing data to the systems that use ice detection for automatic operation. Ice detection messages and PIDS fault messages can appear on the EICAS and maintenance pages.


ADRF Data
Icing Cond
115V AC
Processor And
Heater Power
Ice Det
RDC
RPDU
Common Data Network
PCM
GPM
GPM
GPM
GPM
GPM
GPM
GPM
GPM
GG
GG
FOX
ACS
FOX
ACS
PCM
CCR
Cabinet (2)
Flight Control
Electronics (4)

Engine Anti-Ice System

The Engine Anti-Ice (EAI) system uses hot engine bleed air to keep ice from forming on the inlet cowl. The EAI also keeps ice from forming in the low-pressure booster compressor.

Each engine has an EAI system. Both systems are independent in their operation. The EAI operation is both automatic and manual.

Description

The control of the EAI comes from a Main Engine Data Concentrator (MEDC).

The EAI has these components:

- EAI valve
- Controller Air Cooler (CAC)
- Core valve (PRSOV)
- Temperature sensor
- Fan valve inlet pressure sensor
- Fan valve (PRV)
- Fan valve outlet pressure sensor.

The air for the EAI control and thermal heating comes from the 7th stage of the High Pressure Compressor (HPC).

There are control switches on the P5 panel for EAI. These are the positions of the switches:

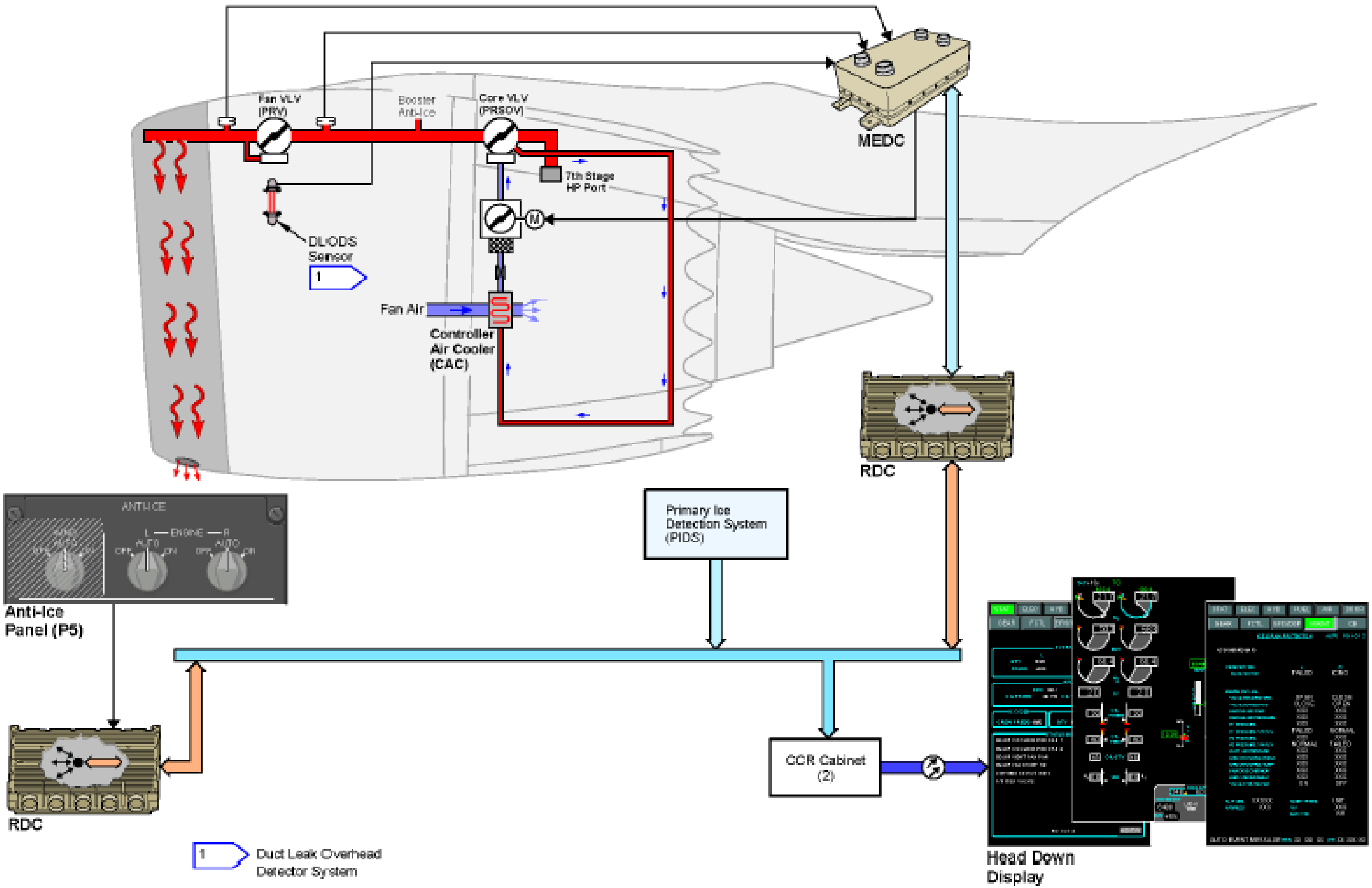
- OFF
- AUTO
- ON.

Operation

When the control switch is on, the MEDC operates the EAI valve on the engine. Air from the core valve body goes through the CAC to the EAI valve. The MEDC controls the EAI valve to regulate the air pressure to the core valve. The core valve opens to send 7th stage HPC bleed air to the fan valve and booster anti-ice. The core valve is used as a Pressure Regulating and Shutoff Valve (PRSOV). The MEDC monitors the fan valve inlet and outlet pressure sensors. The MEDC uses this pressure to control the core valve to regulate the air pressure that goes to the inlet cowl. The MEDC uses the temperature sensor to detect hot air leaks in the system.

The fan valve is a backup PRSOV to the core valve. If the air pressure from the core valve goes above 50 psi, the fan valve begins to modulate closed. This keeps the air pressure in the inlet cowl lip from increasing to more than the maximum pressure.

When the control switch is in AUTO, Primary Ice Detection System (PIDS) ice data goes to the Common Core System (CCS). The CCS sends this ice data through an RDC to the MEDC. The MEDC automatically controls the EAI to operate.


MEDC
Fan VLV (PRV)
Booster Anti-Ice
Core VLV (PRSOV)
7th Stage HP Port
DLODS Sensor
1
Fan Air
Controller Air Cooler (CAC)
RDC
Primary Ice Detection System (PIDS)
ANTI-ICE
ENGINE
OFF
AUTO
ON
Anti-Ice Panel (P5)
RDC
CCR Cabinet (2)
Head Down Display
1
Duct Leak Overhead Detector System

Wing Ice Protection System

The Wing Ice Protection System (WIPS) prevents ice buildup on four slats of each wing. The WIPS can also remove ice buildup on the same four slats on each wing.

Description

The WIPS uses electrical power to heat the eight slats for anti-ice and de-ice operation.

Each of the four slats on each wing has three heater mats. The mats are bonded to the inner surface of each slat. Each heater mat gets 235V AC power from three different power panels:

- P100
- P150
- P200.

There are 48 heater mats.

The center heater mat in each slat has a temperature sensor. The sensors are used to control the amount of electrical power going to heater mats.

Control of the AC electrical power to each of the heater mats comes from one of 24 control cards. The control cards are in the Wing Ice Protection Controller Unit (WIPCU). Each card controls the heater mats for the same slat position on both wings.

Control of WIPS is either manual or automatic. The control switch has AUTO and ON positions. In AUTO, WIPS operates when the Primary Ice Detection System (PIDS) sends icing data to the Common Core System (CCS).

Operation

When the WING control switch is in AUTO, WIPS operation begins at takeoff when ice is detected.

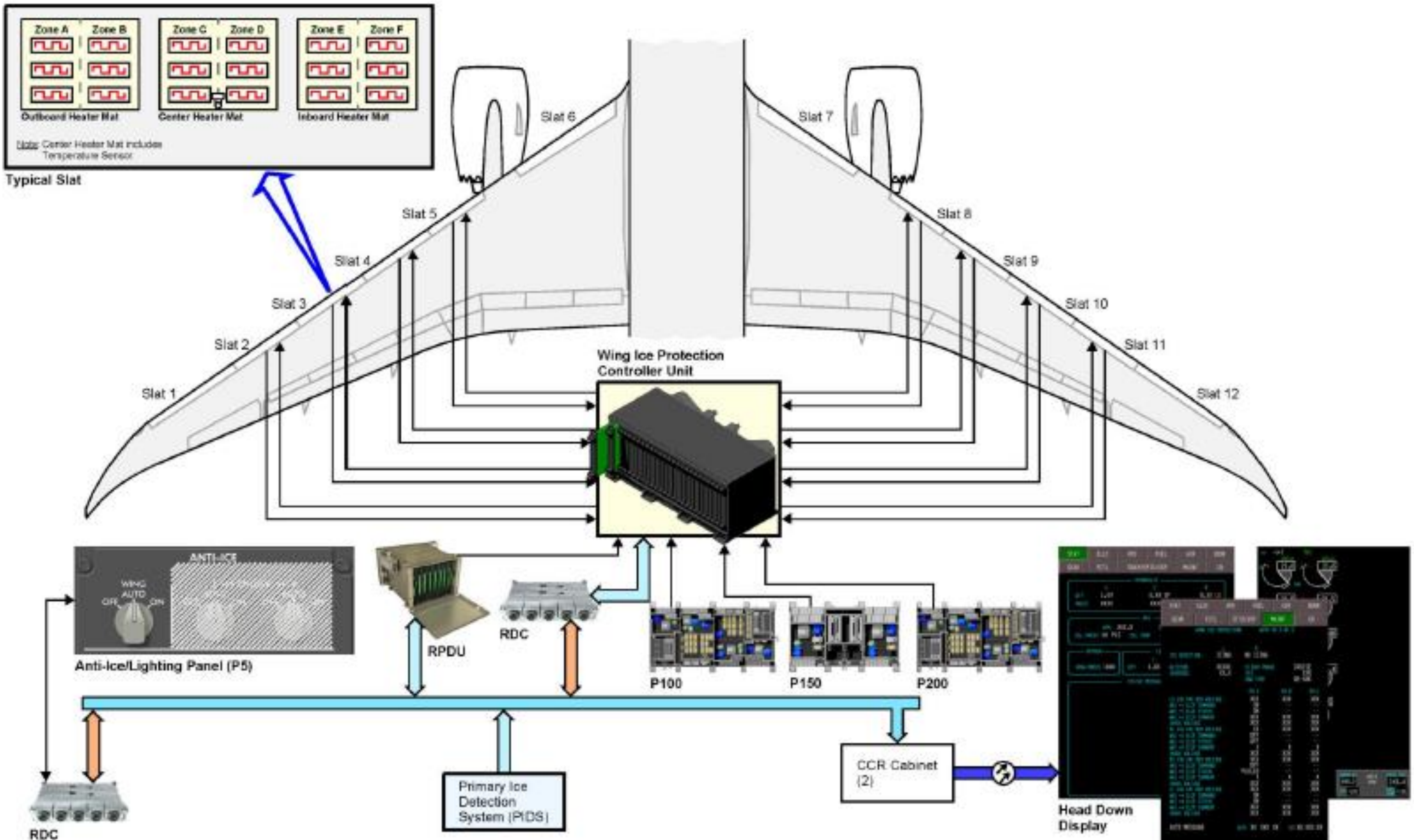
There are three operation modes for WIPS:

- Anti-ice
- Limited anti-ice
- De-ice.

In anti-ice mode, continuous electrical power goes to the heater mats on all eight slats. WIPS operates in this mode from takeoff to an altitude of 20,300 feet.

In the limited anti-ice mode, the outboard heated slat on each wing does not get electrical power. The limited anti-ice mode operates from 20,300 to 30,500 feet. The three inboard slats of each wing continue to be heated in the anti-ice mode.

For altitudes above 30,500 feet, WIPS operates in a de-ice mode. In the de-ice mode, each slat has a heating cycle from between one and four minutes. Built-up ice is loosened, and airflow takes the ice off the slat.


Zone A
Zone B
Zone C
Zone D
Zone E
Zone F
Outboard Heater Mat
Center Heater Mat
Inboard Heater Mat
Note: Center Heater Mat includes Temperature Sensor
Typical Slat
Slat 1
Slat 2
Slat 3
Slat 4
Slat 5
Slat 6
Slat 7
Slat 8
Slat 9
Slat 10
Slat 11
Slat 12
Wing Ice Protection Controller Unit
ANTI-ICE
WING
AUTO
OFF
ON
Anti-Ice/Lighting Panel (P5)
RPDU
RDC
P100
P150
P200
RDC
Primary Ice Detection System (PIDS)
CCR Cabinet (2)
Head Down Display

Cabin Air Compressor Inlet Ice Protection

The Cabin Air Compressor (CAC) Inlet Ice Protection System (CIPS) removes ice buildup on the inlet for the CACs.

The CIPS uses electrical power for the de-ice function.

Description

There are two CAC inlets, one inlet on each side of the airplane. One inlet sends air to two CACs.

Control of CIPS comes from hosted applications in the Common Core System (CCS).

The CIPS operates automatically with the Engine Anti-Ice (EAI) system manually or automatically selected on. One or both CACs connected to the inlet must be on to arm the CIPS to operate.

Each CIPS has two temperature sensors. The CCS uses the temperature sensor in flight to control electrical power to the CIPS heating elements.

On the ground, the CCS sends the temperature data to the Air Data Reference Function (ADRF). The ADRF use this data in the Total Air Temperature (TAT) calculation on the ground.

The CIPS does not operate with the airplane on the ground. The CIPS does not operate in the air with the CAC inlet deflector not retracted.

Operation

In the air, CIPS operates for one of these conditions:

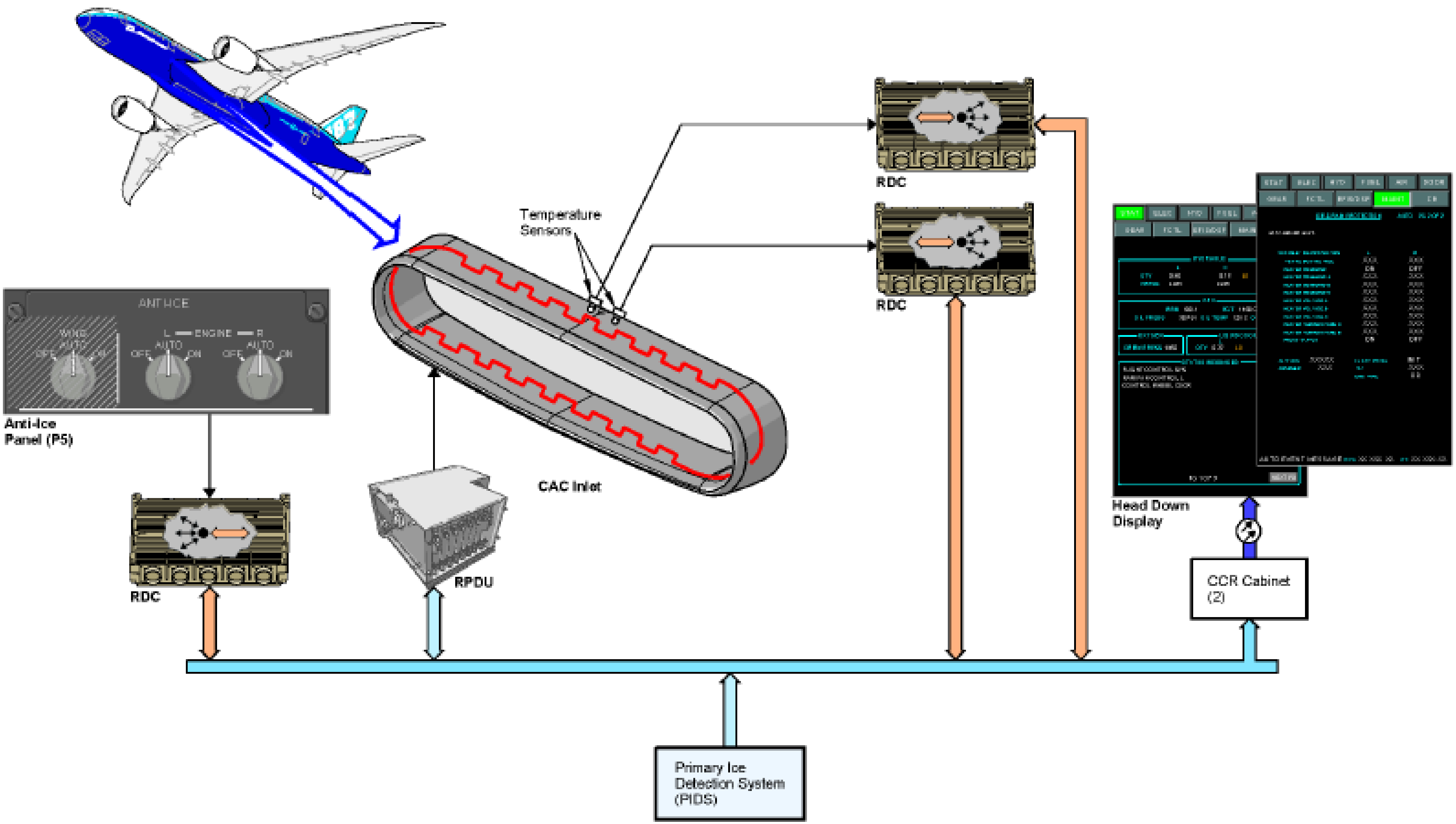
- Onside EAI control switch selected to ON
- Onside EAI control switch selected to AUTO and Primary Ice Detection System (PIDS) ice detected.

When CIPS is on, 115V AC power goes from a Remote Power Distribution Unit (RPDU) to the heating elements. The power is cycled to the heating element. The de-ice cycle time is:

- One minute on
- 15 minutes off.

The CCS hosted application uses the temperature sensor to control the CAC inlet temperature to 285°F (141°C).

Each CIPS has two thermal fuses for overheat protection. The thermal fuses are set to open at 363°F (184°C).


Temperature
Sensors
RDC
RDC
ANTI-ICE
WING
AUTO
OFF
ON
L
ENGINE
R
AUTO
OFF
ON
AUTO
OFF
ON
Anti-Ice
Panel (P5)
CAC Inlet
RDC
RPDU
Head Down
Display
CCR Cabinet
(2)
Primary Ice
Detection System
(PIDS)

Air Data Sensor Heat

The air data sensor heat system prevents ice buildup on external sensor probes.

The air data sensor heat system uses electrical power to heat these probes:

- Pitot probes (3)
- Angle-of-Attack (AOA) probes (2)
- Total Air Temperature (TAT) probe.

Description

Control of air data sensor heat is automatic. There are no control switches in the flight deck for sensor heat. Indications show on EICAS and maintenance pages of the Head-Down Displays (HDD).

Control of the air data sensor heat comes from hosted applications in the Common Core System (CCS). The hosted applications use data from the Air Data Reference Functions (ADRF) to operate the sensor heat system.

Electrical power for the sensor heat comes from Remote Power Distribution Units (RPDU).

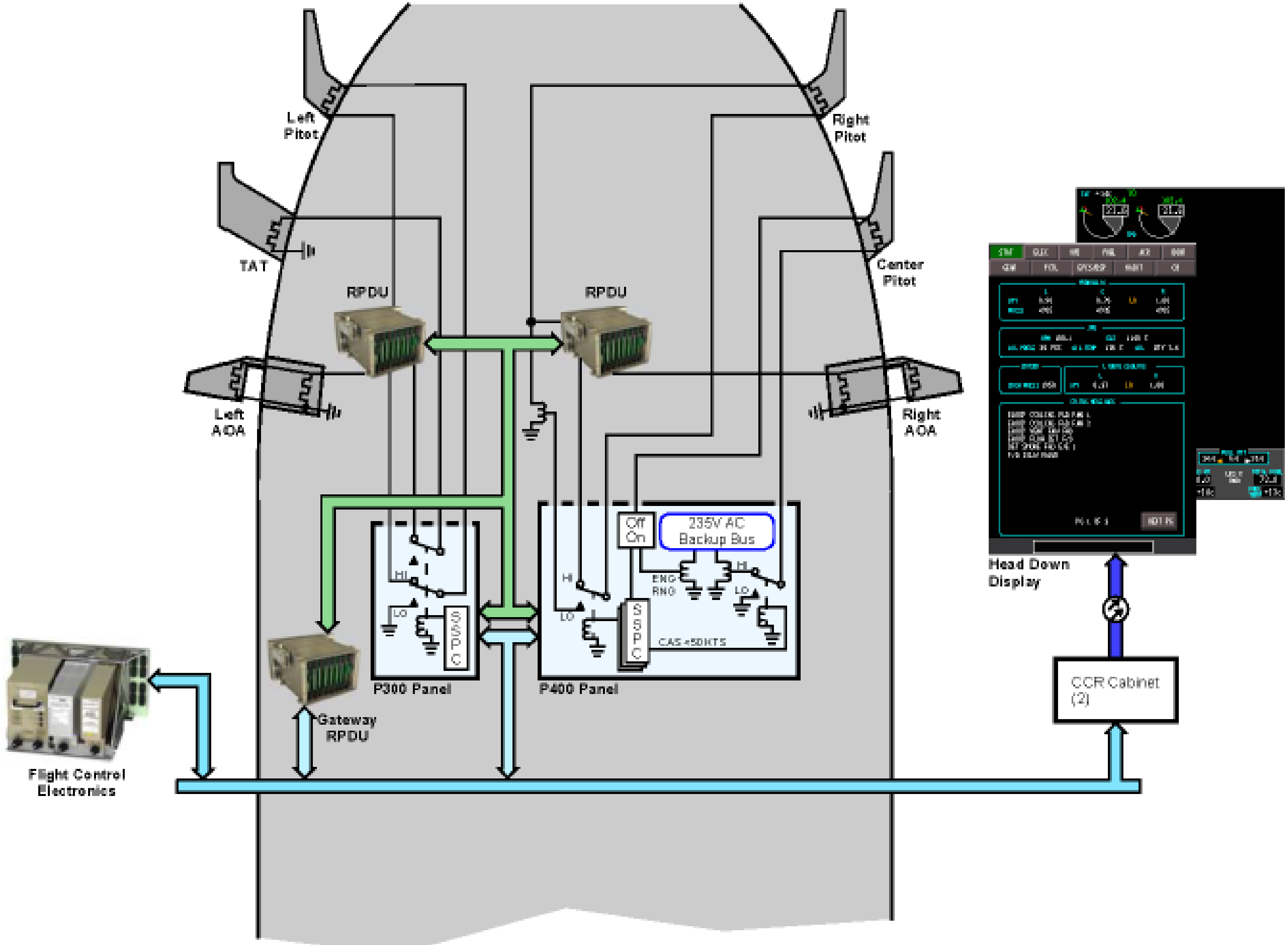
Operation

Left and right pitot heat has two power levels, 115V AC and 200V AC. There must be power on the airplane and an engine running for pitot heat to operate. When airspeed is less than 50 knots, 115V AC power goes to the sensor probe heat elements. When airspeed is more than 50 knots, 200V AC power goes to the same probe heat elements to increase the temperature.

The center pitot heat gets one or two phases of 115V AC power. When power is on the airplane, an engine is running, and airspeed is less than 50 knots, single-phase power goes to the probe. When airspeed is greater than 50 knots, two phases of power go to the probe to increase the temperature.

The AOA probes get 115V AC power for heat elements in both the sensor vanes and the sensor case. Power goes to the elements with electrical power on the airplane, at least one engine running, and airspeed more than 50 knots.

The TAT probe gets 115V AC power for the heat element. The TAT probe heat comes on with electrical power on the airplane, one engine running, and airspeed more than 50 knots.


Left Pitot
Right Pitot
TAT
Center Pitot
RPDU
RPDU
Left AOA
Right AOA
Off
On
235V AC Backup Bus
HI
LO
SSPC
ENG RNG
CAS <50KTS
P300 Panel
P400 Panel
Gateway RPDU
Flight Control Electronics
Head Down Display
CCR Cabinet (2)

Window Heat System

The window heat system prevents the buildup of ice and fog on the four flight deck windows. By keeping the windows warmer, the window heat system also helps to prevent the flight deck windows from shattering due to a bird strike.

The two forward windows have both primary and backup heat systems. The two side windows have a primary system only.

Description

The control of the window heat system comes from hosted applications in the Common Core System (CCS).

Control of the window heat system is automatic. The control switches on the P5 panel are for the flight crew to de-select or reset window heat.

The two forward windows have both anti-fog and anti-ice protection. The two side windows have anti-fog protection only. The backup heat system for the forward windows is anti-fog protection only.

The CCS uses Remote Power Distribution Units (RPDU) to turn the window heat system on and off. When on, the RPDUs send 115V AC bus power to Solid State Power Controllers (SSPC) in two Power Distribution Panels (PDP). The SSPCs control power to the windows.

Electrical power goes through conductive transparent layers. The conductive layers are between the glass and acrylic layers of each window. Each window also has primary and spare temperature sensors. The CCS uses the temperature sensors to control the amount of power that goes to heat the windows, and to protect the windows from overheating.

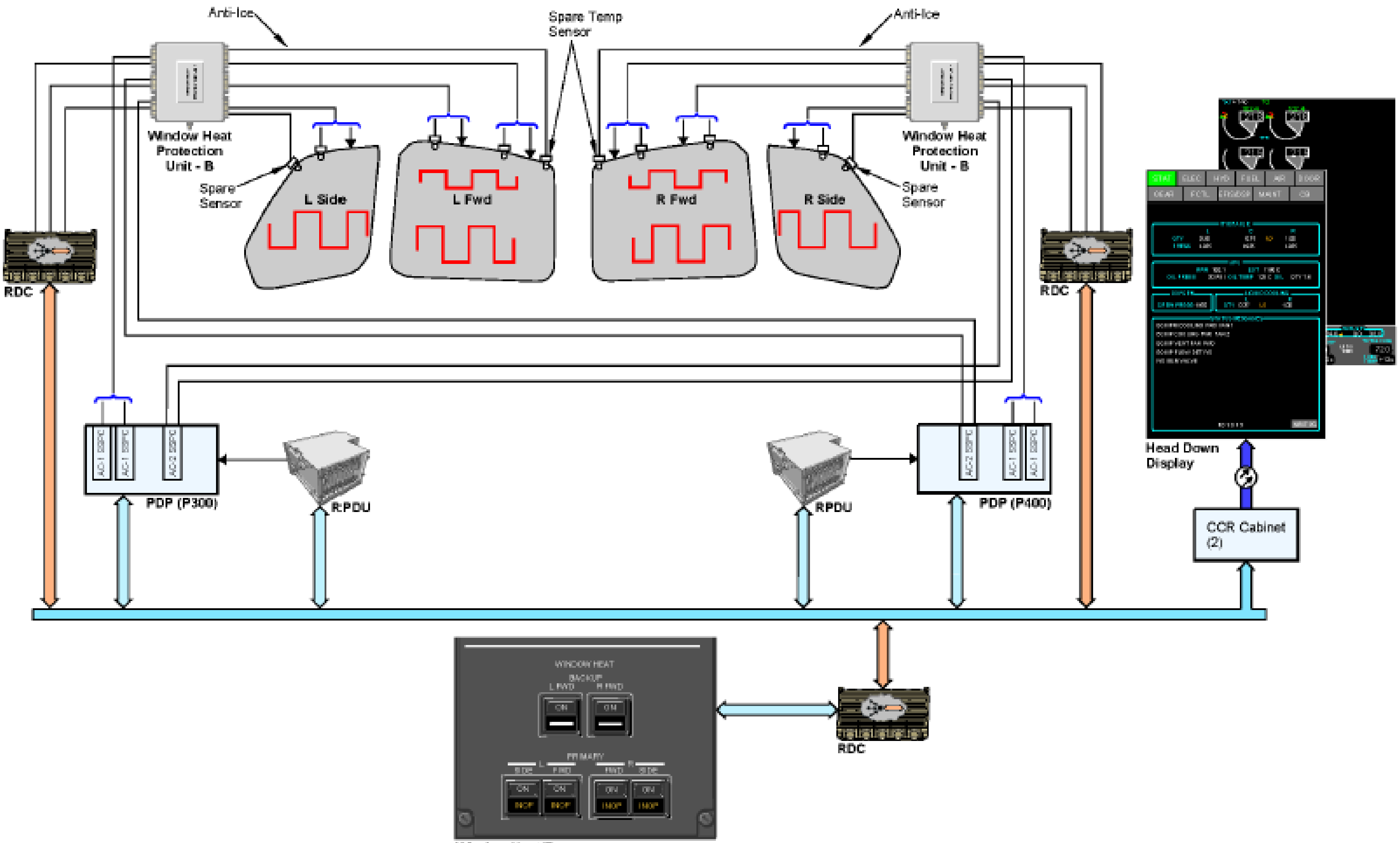
The interface to the windows for power, protection, and electrical grounds are the two Window Heat Protection Units (WHPU). This is because the carbon reinforced plastic composite structure does not conduct electricity.

Window heat indications are on the control switches, and the Head- Down Display (HDD) EICAS and maintenance pages.

Operation

When power is on the airplane, the CCS sends 33 percent of total power to the windows for a short time. This prevents thermal shock to a cold window. After the time interval, 100 percent of available power goes to the windows until the target temperature is reached.

When necessary, the CCS will cycle the power to the windows on and off to maintain target temperature without overheating.


Anti-Ice
Spare Temp Sensor
Anti-Ice
Window Heat Protection Unit - B
Spare Sensor
L Side
L Fwd
R Fwd
R Side
Window Heat Protection Unit - B
Spare Sensor
RDC
RDC
Head Down Display
PDP (P300)
R PDU
R PDU
PDP (P400)
CCR Cabinet (2)
RDC
Window Heat/Emergency Lights Module (P5)

Windshield Wiper and Wash System

The windshield wiper and wash system keeps the two forward flight deck windows clean and clear of water. The system is used only on the ground.

Control of the windshield wiper and wash system is manual. There is a wiper control switch and a washer control switch for each of the two forward windows.

Description

Each windshield wiper gets control power from a Wiper Electronic Control Unit (WECU). The WECUs get electrical power from a Remote Power Distribution Unit (RPDU). The WECUs send wiper control data to the common core system through Remote Data Concentrators (RDC). Wiper data appears on Head-Down Displays (HDD) maintenance pages.

The WECUs are in the forward upper part of the forward Electronic Equipment (EE) compartment. They are directly below and forward of the windows.

Each wiper has an electric motor, also below and forward of the window.

The windshield wash system has a pump tank assembly in the flight deck. The assembly is in a closet on the left side of the flight deck, behind the captain. The assembly has a solution tank and two electric motor operate pumps, one for each window spray nozzle.

The solution tank is made of a translucent plastic, which makes it easy to see the level of the solution remaining in the tank. The tank must be re-serviced periodically. The tank can be easily serviced without having to be removed from the pump tank assembly.

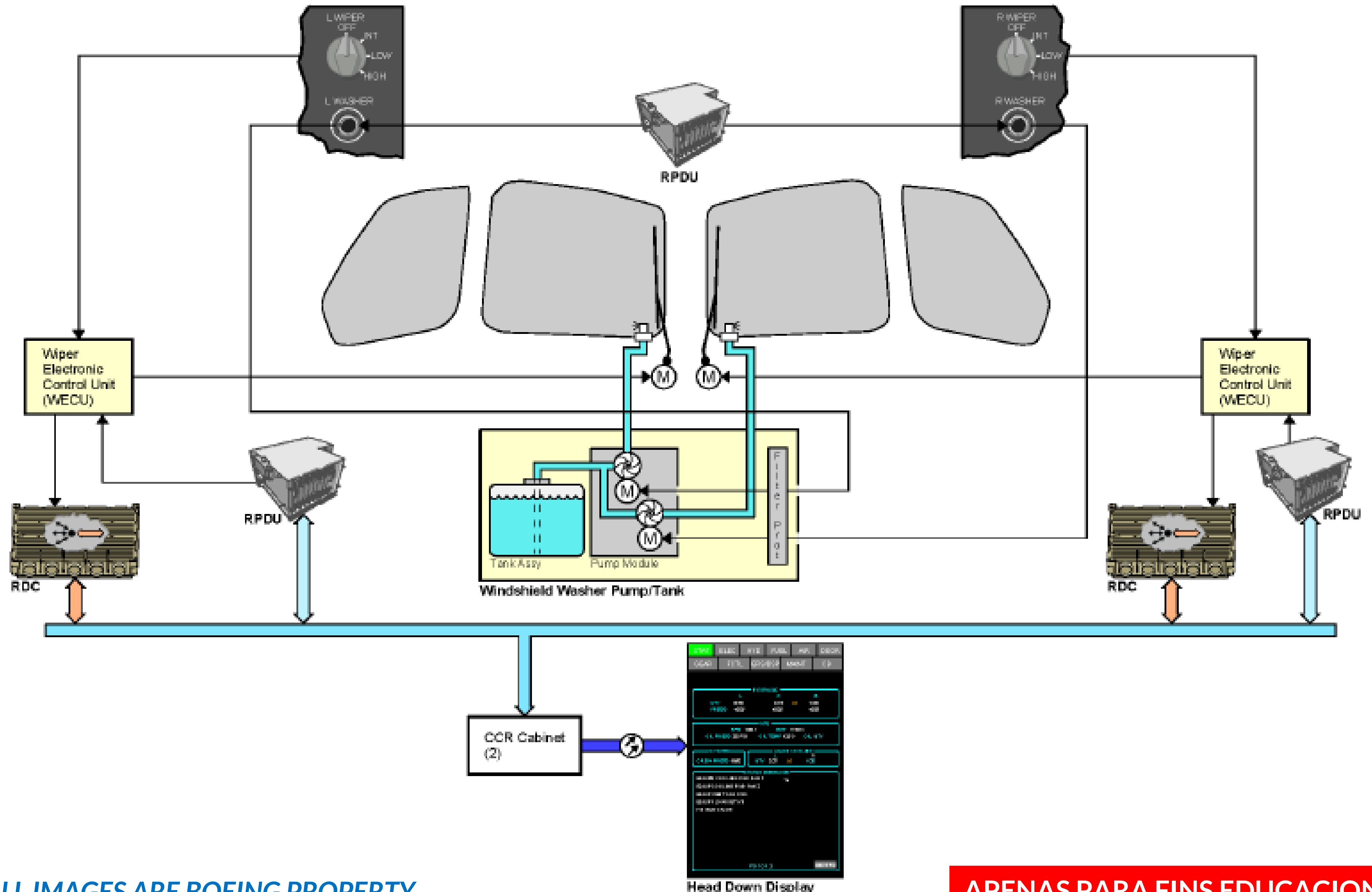
Operation

The wiper control switches are the four-position rotary type. The switch has an intermittent (INT) position. In this position, the wiper cycles every seven seconds. In LOW, the wiper cycles 80 times per minute. In HIGH, the wiper cycles 120 times per minute.

When the switches are selected to OFF, the wipers automatically move to the park position.

The windshield wash system sprays a cleaning solution onto the two forward windows. The wash control switches are the pushbutton type. An RPDU sends 28V DC power to the two washer switches. When pushed, the switch sends the 28V DC power to one of two pump motors in the windshield washer pump tank assembly.

The pump will operate as long as the spray switch is pushed.


L WIPER
OFF
INT
LOW
HIGH
L WASHER
R WIPER
OFF
INT
LOW
HIGH
R WASHER
RPDU
Wiper Electronic Control Unit (WECU)
Wiper Electronic Control Unit (WECU)
M
M
RPDU
RDC
RPDU
RDC
Tank Assy
Pump Module
Filter Prot
M
M
Windshield Washer Pump/Tank
CCR Cabinet (2)
Head Down Display

Water and Waste System Heat

The water and waste systems heat does these functions:

- Prevents ice on the two drain fittings and flapper valves in the lavatory service panel
- Prevents ice in the potable water supply lines.

Description

Control of the water and waste systems heat is automatic. The control comes from hosted applications in the Common Core System (CCS).

There are two types of heaters for the water lines. One type has heating elements integrated in the water line. The other type are heating elements in manifolds. These heating elements are molded to the form of the water lines.

There are heater and water temperature sensors in these areas of the airplane:

- Bulk cargo compartment
- Aft cargo compartment
- Wing box
- Forward cargo compartment
- Lavatory waste tank drain fittings.

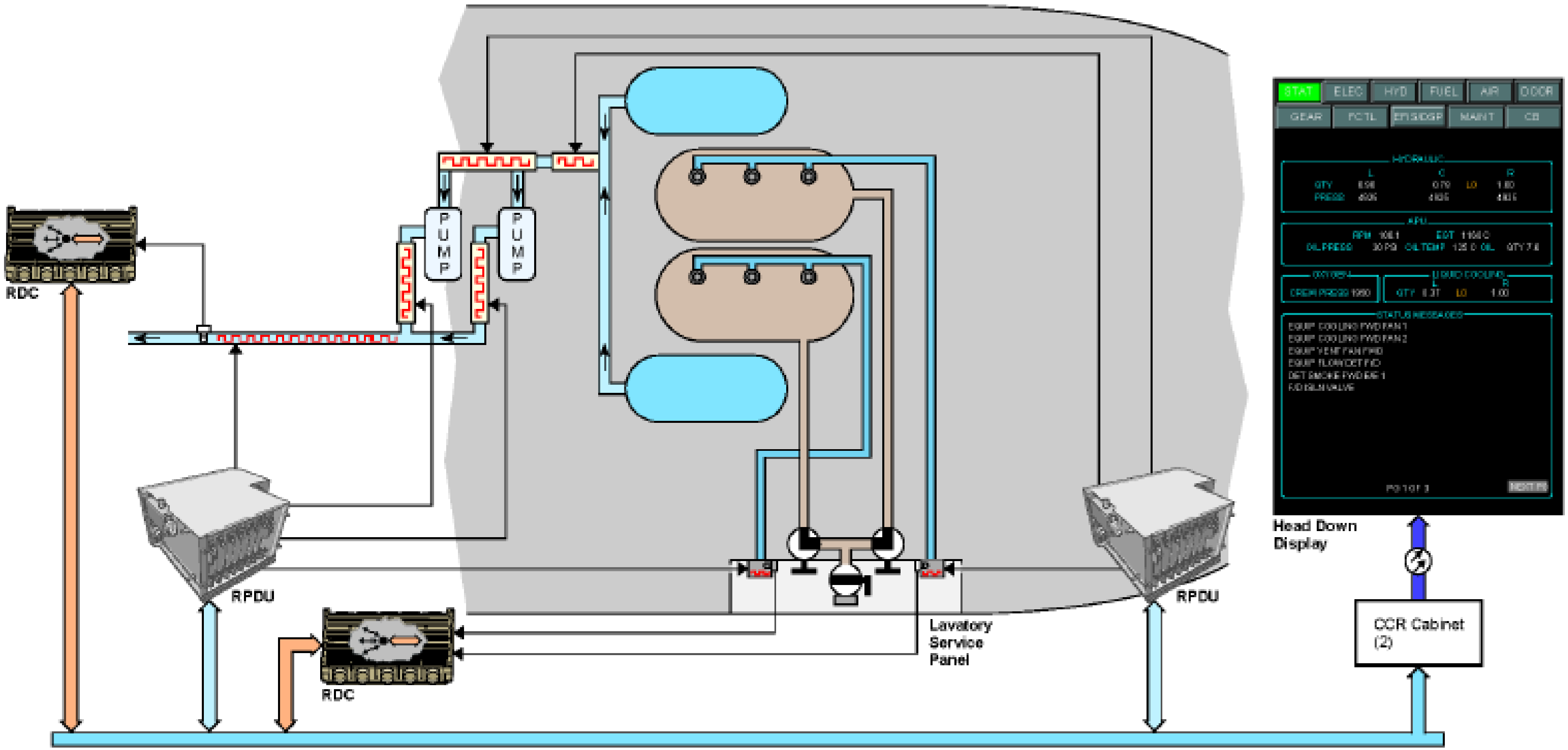
There are 11 potable water hoses that are heated. There are six water temperature sensors.

The CCS monitors the drain fitting and water temperature sensors through remote data concentrators. The CCS controls the electrical power to the heater elements through Remote Power Distribution Units (RPDU).

Operation

When electrical power is on the airplane, the CCS hosted application monitors the temperature of the water in the supply lines. When the water temperature is at or near freezing, the CCS controls the RPDUs to send 115V AC power to the heater elements.

The water and waste systems heat operates on the ground and in flight. Water and waste systems heat data appears on maintenance pages of the Head-Down Displays (HDD).


RDC
RPDU
RDC
RPDU
Lavatory Service Panel
Head Down Display
CCR Cabinet (2)
PUMP
PUMP