TECHSAVIATION
Training Center

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APENAS PARA FINS EDUCACIONAIS

Pack Control Unit

Each air conditioning pack gets control from a Pack Control Unit (PCU). Each PCU has two control channels. Each PCU channel gets control power from a different Remote Power Distribution Unit (RPDU). One PCU channel is in control, and the other channel is standby. PCU control channel change occurs with each new flight.

The PCUs communicate with each other over a Controller Area Network (CAN) bus.

The PCUs are air cooled. Cooling air comes from the two lower recirculation system Heat Exchangers (HX).

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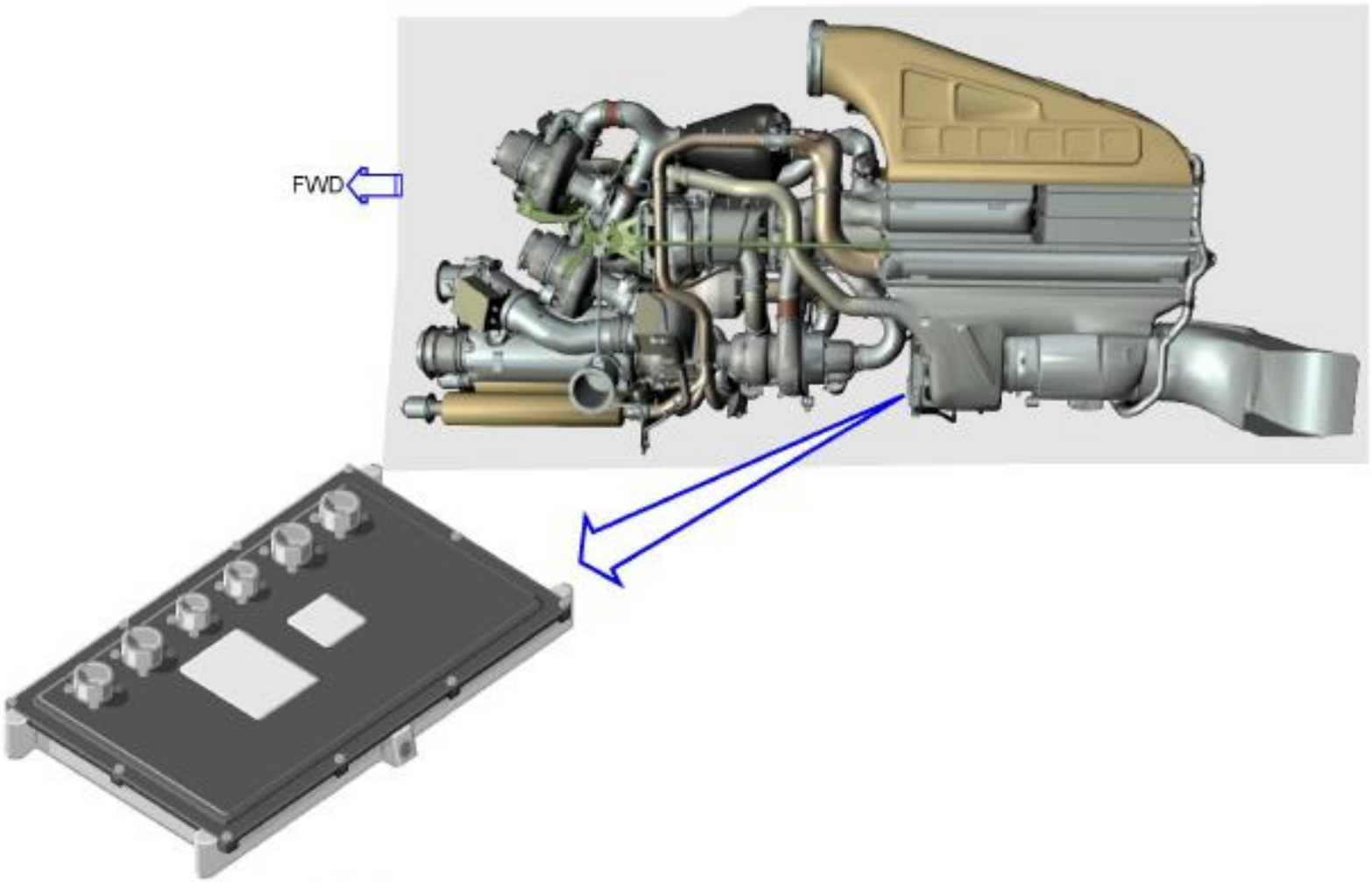

Pack Control Unit

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Cabin Air Compressors

Each air conditioning pack and trim air system gets pressurized air from one or two Cabin Air Compressors (CAC). Each CAC has these components:

- Variable speed AC electric motor
- Variable Diffuser Actuator (VDA)
- Axial flow compressor
- Add Heat Valve (AHV)
- Inlet pressure sensor
- Outlet pressure sensor
- Outlet temperature sensor (2)

The CACs have air bearings, and the CAC motors are air cooled.

Each CAC gets control power from a Common Motor Starter Controller (CMSC). The CMSCs get +/- 270V DC power from an Autotransformer Rectifier Unit (ATRU) through a 270V DC bus.

Control commands for the CMSCs to control the CACs come from a Pack Control Unit (PCU). There is one PCU for each pack. Each PCU can control two CACs through the CMSCs.

CAC Operation

When both pack switches are selected to AUTO on the P5 panel, this is the CAC operation sequence:

- One CAC of the left pack operates with three ground power units connected
- One CAC of each pack operates with both APU Starter Generators (ASG) connected
- Both CACs of each pack operate with all four engine-driven Variable Frequency Starter Generators (VFSG) connected.

The PCUs use components to protect the CACs from compressor surge and over-temperature:

- Inlet and outlet pressure sensors
- Outlet temperature sensors
- Variable diffuser actuator
- Add heat valve.

Air for the CACs comes from an inlet duct in the lower left and right sides of the fuselage. Two CACs share one inlet duct. Each CAC inlet is protected by an inlet deflector door on the ground.

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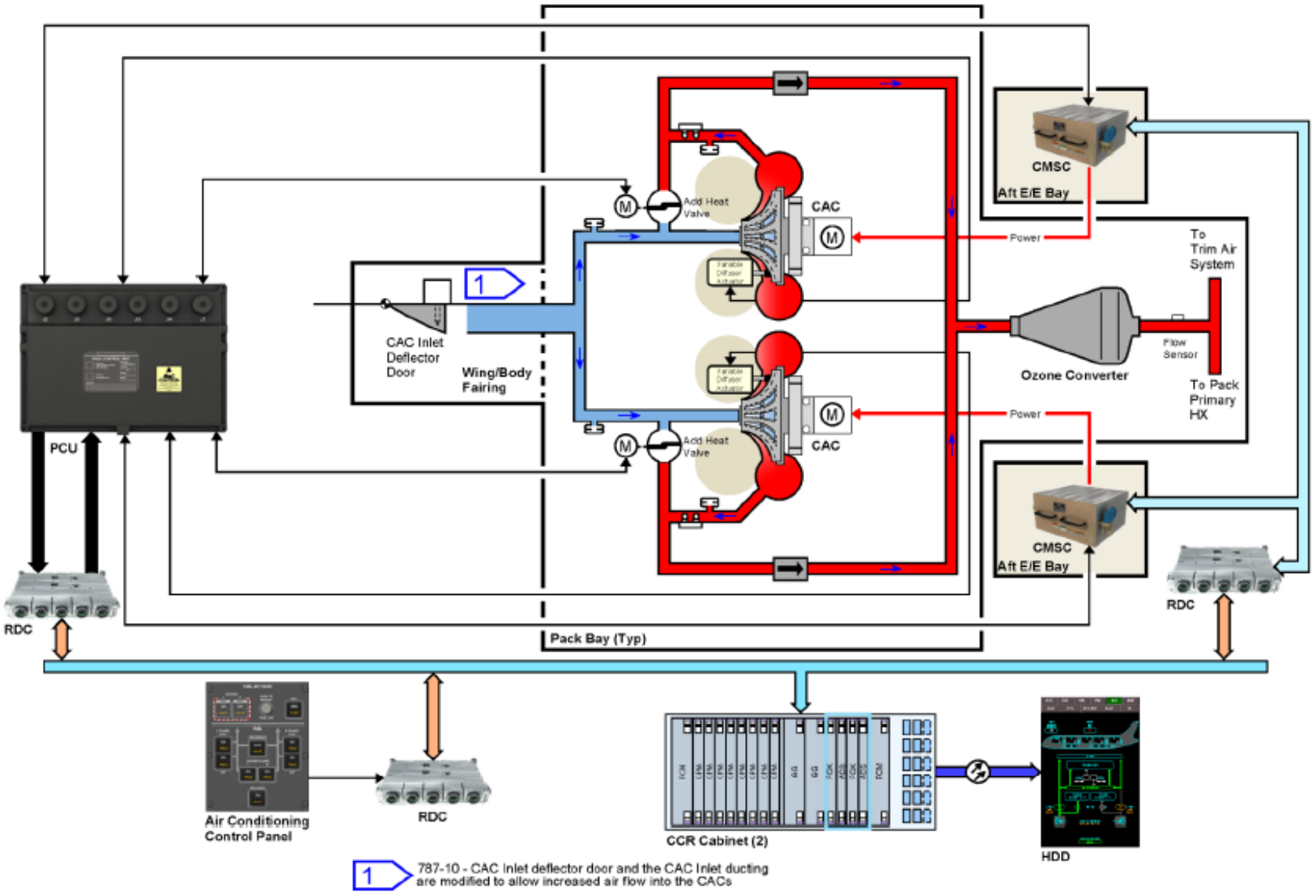

Cabin Air Compressors

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Air Conditioning Pack

There are two air conditioning packs. The packs are below the center fuel tank.

The Pack Control Unit (PCU) controls most components in the pack.

Pressurized, hot air from the Cabin Air Compressors (CAC) goes to both the Air Cycle Machine (ACM) and trim air system in the pack.

Hot air for the ACM goes through the primary Heat Exchanger (HX), which cools the air that goes to the ACM and ACM Bypass Valve (ABV). Hot, high-pressure ACM compressor discharge air goes through the secondary HX.

From the secondary HX, cooler air goes to the condenser, with the Economy Cooling Valve (ECV) closed. The condenser uses cold ACM T1 turbine discharge air to cool the air enough for moisture in the air to form as water. This air goes to the water extractor, then to the ACM T1 turbine. Water from the extractor goes to a nozzle in the ram air duct.

The warmer air goes to the ACM T2 turbine. Very cold T2 turbine discharge air goes to the compact mixer. The PCU uses the ABV to add warmer air to the T2 turbine discharge air. This air temperature represents that which is set as an average for all four passenger cabin zones, and separately for the flight deck, by the flight crew. This is ACM discharge air.

This air goes to the compact mixer. Lower recirculation system air that goes through the lower recirculation HX mixes with the ACM discharge air. This air goes to the plenum in the mix bay, aft of forward cargo, and then to the four passenger cabin zones. ACM discharge air also bypasses the compact mixer and mixes with hot air from the flight deck trim air valve. This air goes directly to the flight deck.

The PCU opens the Low Limit Valve (LLV) when ACM T1 turbine discharge air temperature is below freezing.

Above 29,000 feet altitude, the PCU opens the ECV. This causes the ACM compressor discharge air to bypass the condenser, water extractor, and T1 turbine. This lowers air load demand on the CACs. Above 29,000 feet, the moisture content in the ambient air is already very low.

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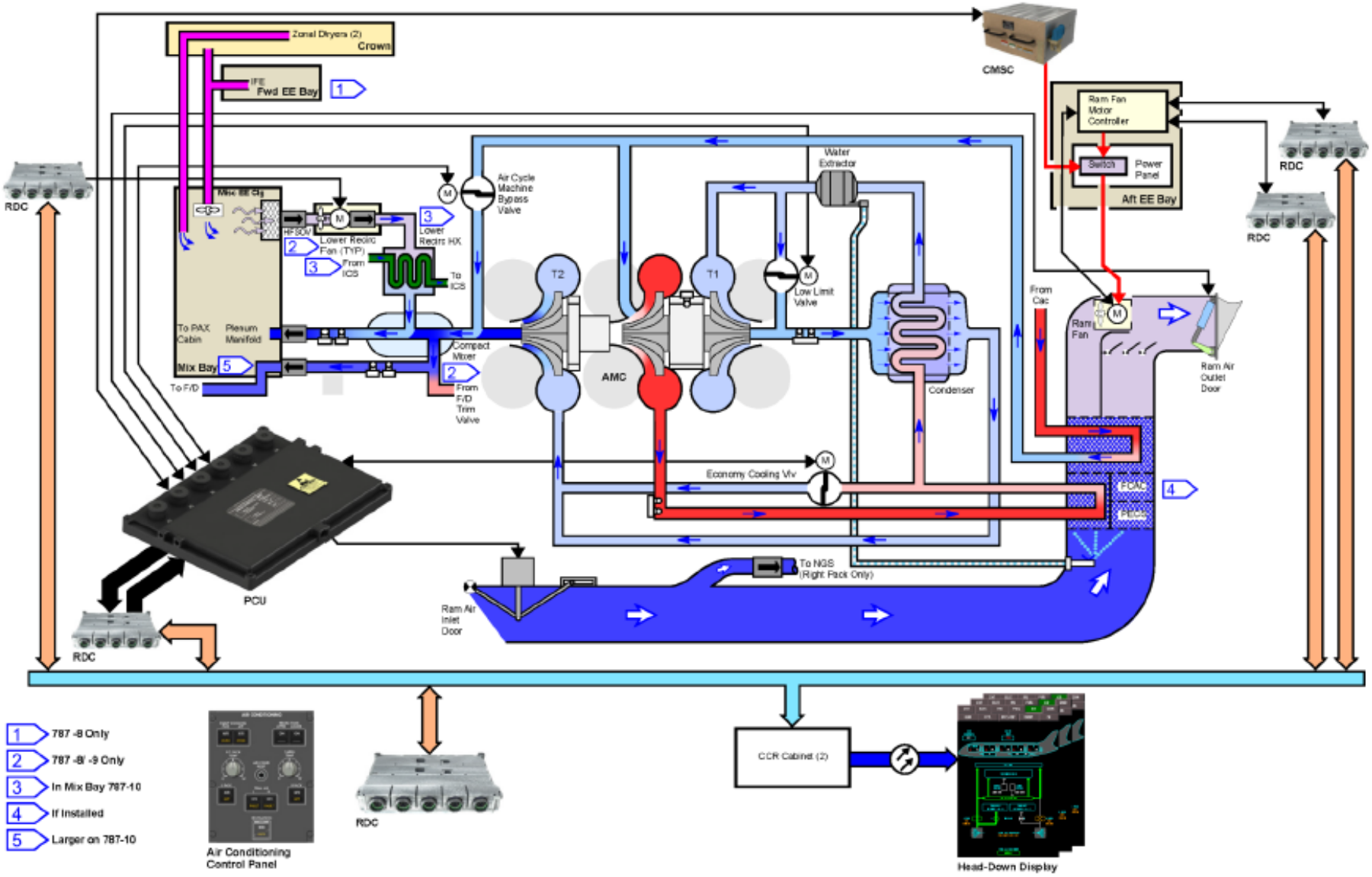

Air Conditioning Pack

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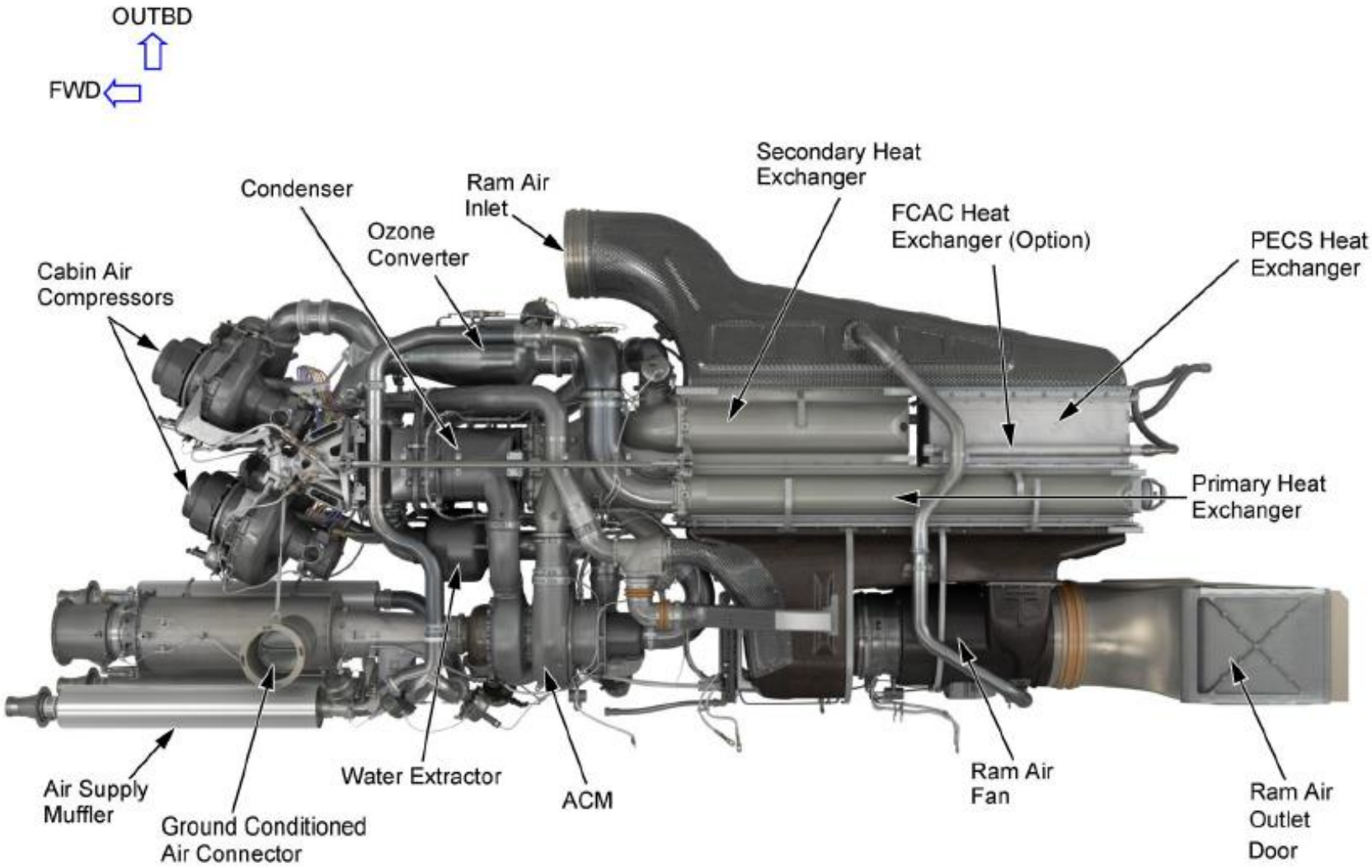

787-10
Left Pack Shown
(Below Looking Up)

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Trim Air Systems

Each air conditioning pack has a trim air system. The Pack Control Unit (PCU) for that pack controls that trim air system. Each PCU controls a trim valve for the flight deck. Each PCU controls two trim valves for two of the four passenger cabin zones. Two trim air control switches are on the air conditioning panel in the flight deck.

The PCU uses a Pressure Regulating Valve (PRV) to keep trim air pressure more than cabin pressure. The PCU uses a pressure sensor downstream of the PRV for control of the PRV to the correct differential pressure.

Operation

The PCU gets flight deck and passenger cabin selected temperature data from the air conditioning panel in the flight deck through the CCS. The PCU also gets passenger cabin zone temperature data from the CAP through the CCS. Each PCU controls trim air temperature for two of the four passenger cabin zones.

The PCUs control the trim valves to add hot Cabin Air Compressor (CAC) discharge air to the cooler pack discharge air.

Hot trim air for the flight deck is added to the pack discharge air downstream of the compact mixer.

Hot trim air for the passenger cabin zones is added to the pack discharge air downstream of the plenum manifold in the mix bay.

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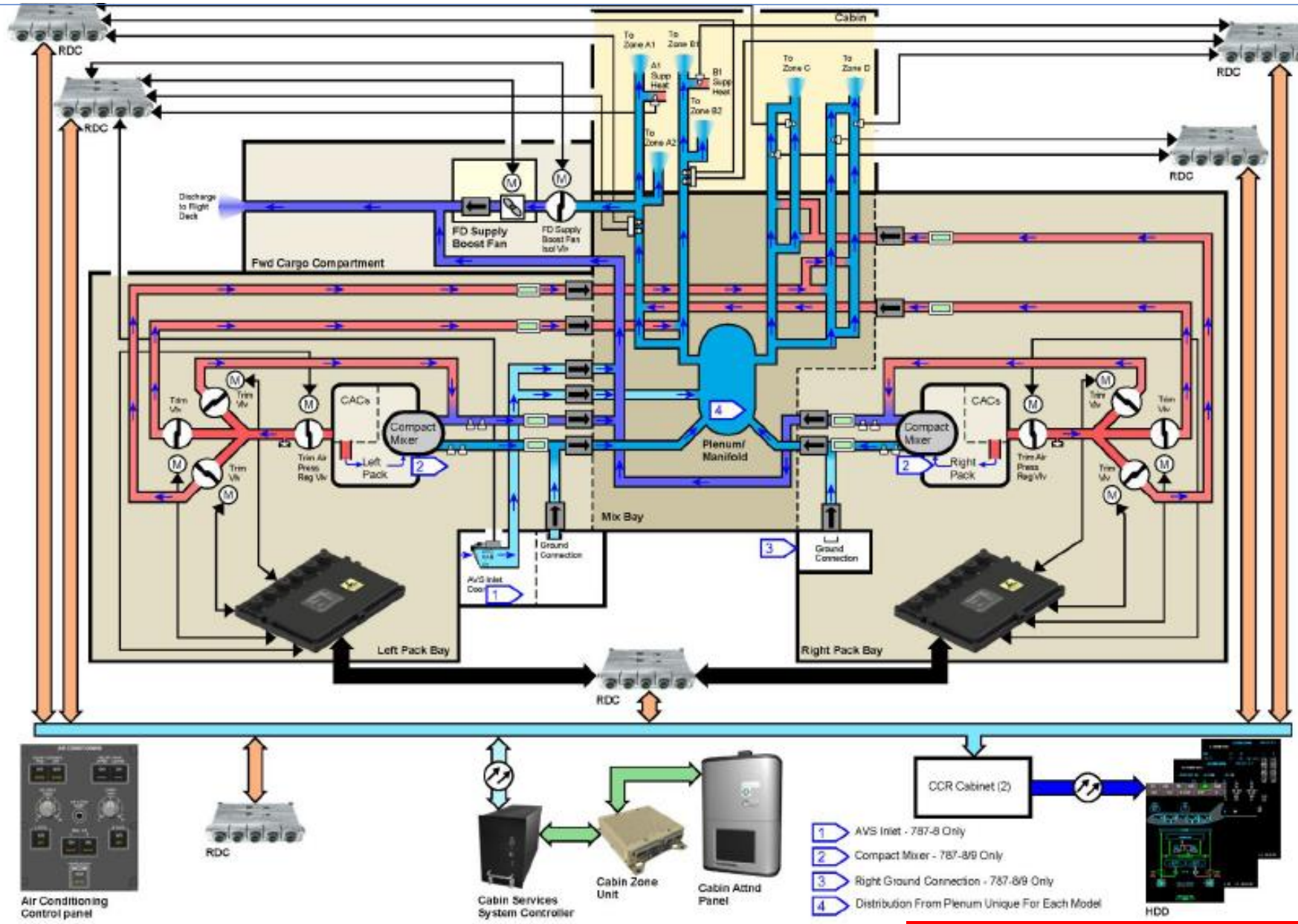

Trim Air Systems

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Conditioned Air Distribution

The conditioned air distribution system sends air into and takes air out of these sections of the airplane:

- Flight deck
- Passenger cabin zones A, B, C, and D
- Forward and aft Electronic Equipment (EE) compartments.

Air for cargo compartment heating comes from the forward and aft EE compartments.

All air goes out of the airplane through the forward and aft Outflow Valves (OFV).

Air comes from these sources:

- Air conditioning packs
- External air conditioning source on the ground

Air from the air conditioning packs goes directly to the flight deck. The air also goes to the plenum/manifold in the mix bay. This air mixes with trim air and goes to the four passenger cabin zones. The air goes to the cabin through risers in both sides of the fuselage. The air comes out of diffusers in the overhead of the cabin, and above the windows. The air makes a swirling motion in the cabin.

Some of the air goes back to the mix bay through air return grilles at the bottom of sidewalls. Air in the crown area goes through the two zonal dryers and the upper recirculation fan. The upper recirculation fan air goes back to the passenger cabin zone distribution system.

Air in the crown that goes through the zonal dryers goes in two different directions. Most of the air goes back into the crown area. The rest of the air is heated. Moisture is added, and it goes back to the mix bay through ducts in the sides of the fuselage.

Air in the mix bay is pulled through the filters of the lower recirculation system. This air goes through the lower recirculation fans, the Integrated Cooling System (ICS) Heat Exchangers (HX), and into the compact mixers in the pack bays. In the compact mixers, the air mixes with pack discharge air and goes back to the plenum/manifold.

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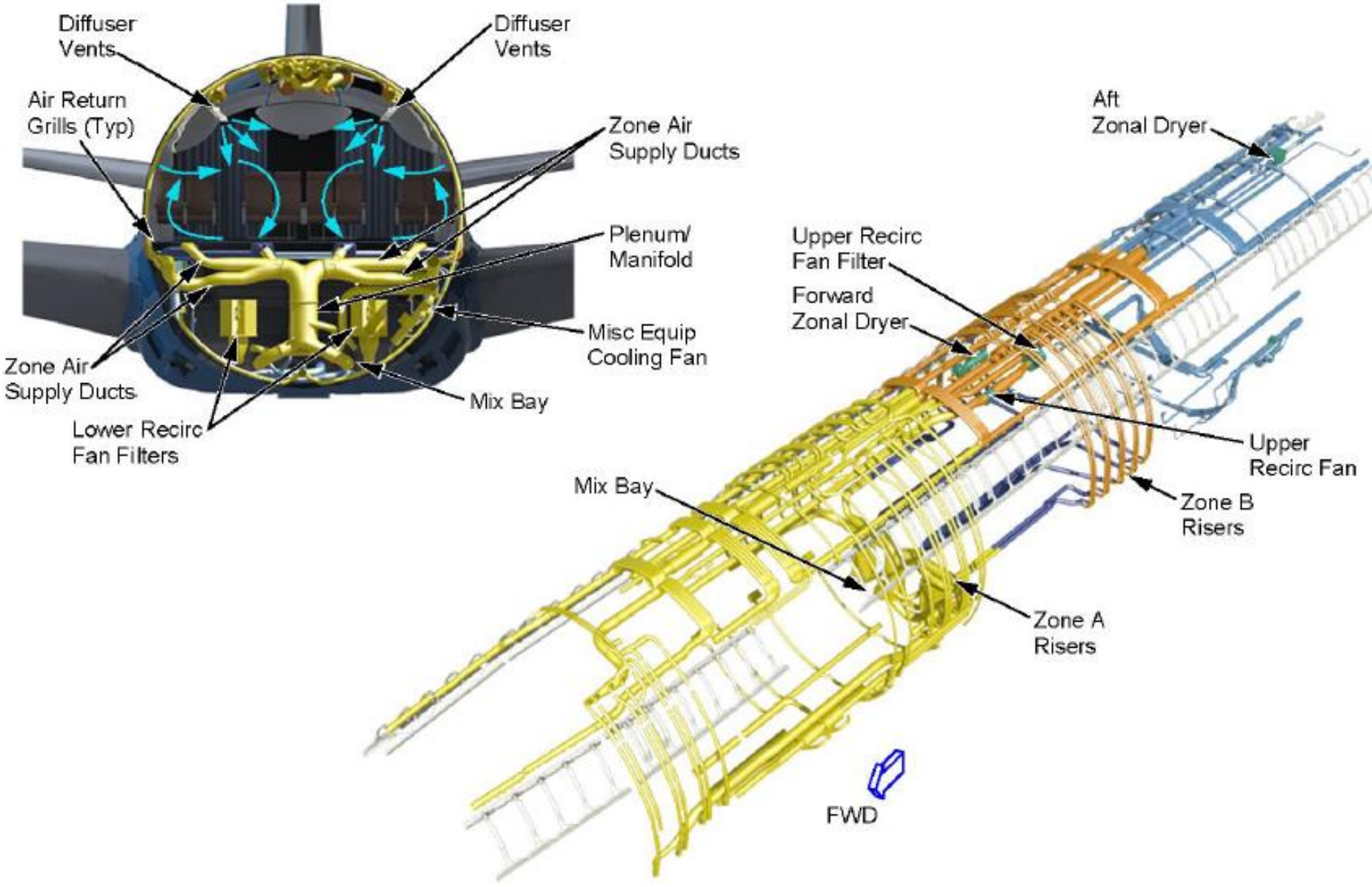

Conditioned Air Distribution

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Air Conditioning Control Panel

The air conditioning control panel is on the right side of the P5 panel.

These are the switches on the air conditioning panel:

- FWD and AFT E QUIP COOLING switches
- UPPER and LOWER RECIRC FANS switches
- FLT DECK TEMP and CABIN TEMP control switches
- AIR COND RESET switch
- L PACK and R PACK control switches
- L and R TRIM AIR switches
- VENTILATION switch (guarded).

Normal indications on the switches are white. Non-normal and fault or caution indications are amber.

The air conditioning reset switch is a single-pulse push-type switch.

The flight deck and cabin temperature control switches are the rotary type.

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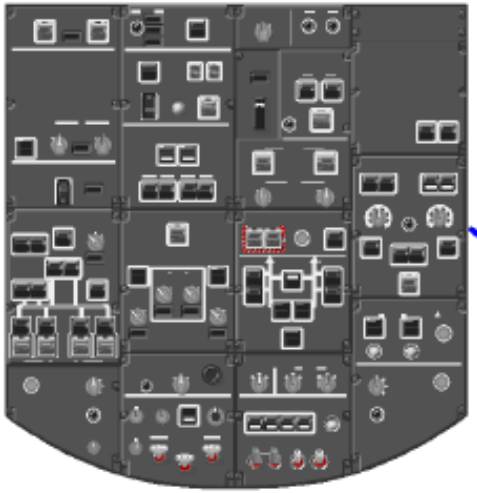

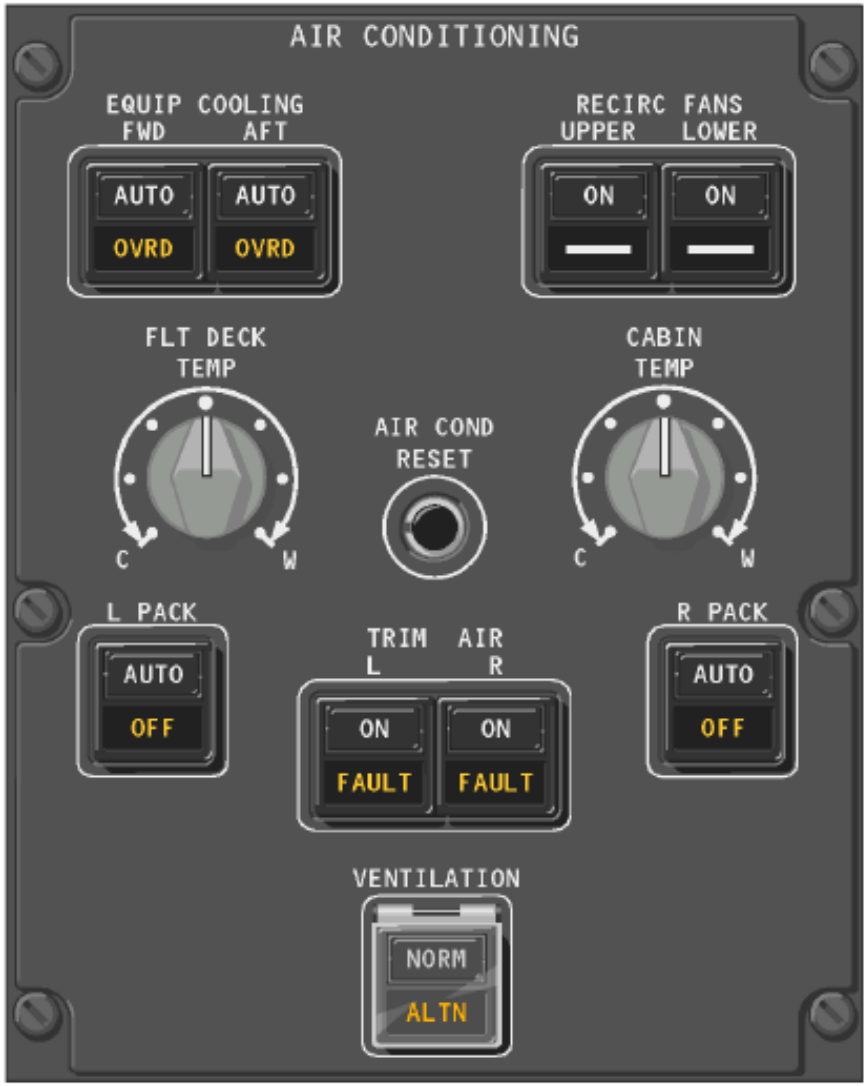

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Air Conditioning Synoptic

The air conditioning synoptic appears on the Head-Down Display (HDD). Select the SYS key on the EICAS Display Select Panel (DSP).

Use the cursor to select AIR at the top of the page to see the synoptic.

Description

The airplane symbol appears at the top of the display. The CABIN OCCUPANTS and MASTER TEMP windows appear above the airplane. The master temperature is the passenger cabin temperature.

All temperatures that appear in magenta are selected. All temperatures that appear in white are actual.

The master temperature is set by the pilots in the flight deck.

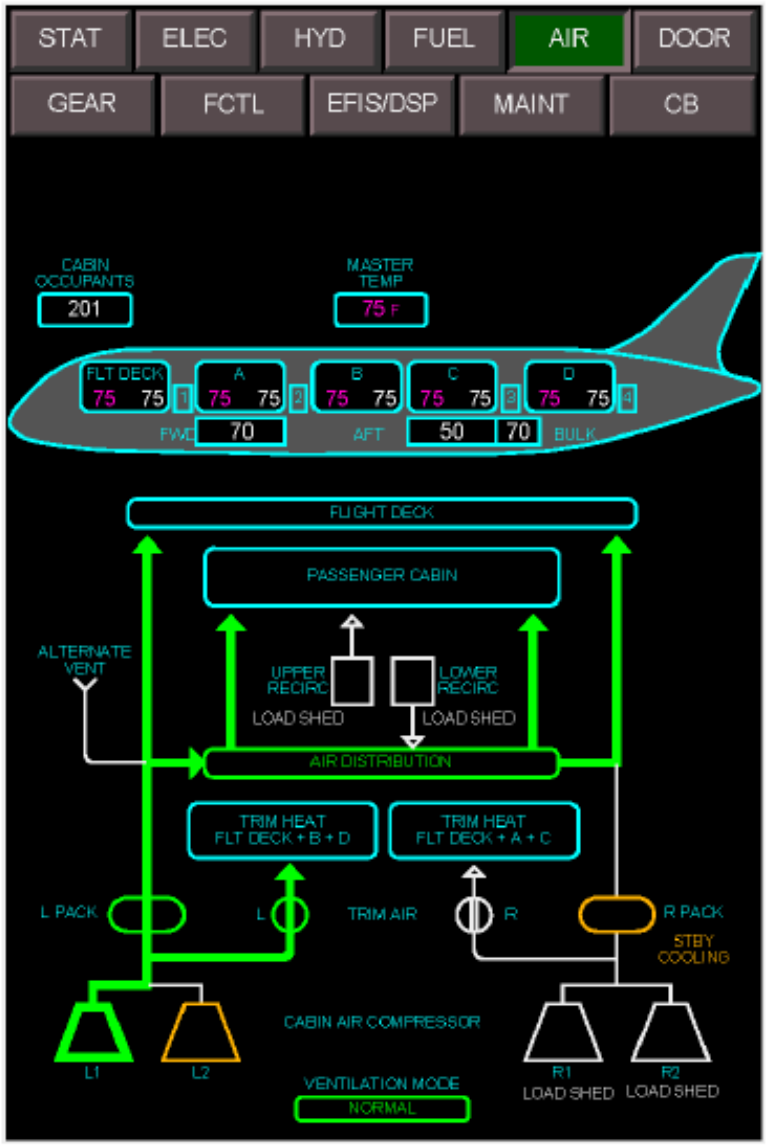
Air flow appears as a thick green line. Operating components appear in green. Components that are not operating appear with a thin white line.

Components that are not operating because of a fault appear amber.

A component that is not operating because of a load shed condition appears with a thin white line. The message LOAD SHED appears in white near the component icon.

These are the valve symbols for the synoptic:

- Green: valve open
- White: valve closed
- Amber X: valve failed open
- Amber X with flow bar: valve failed closed
- Thin white line: valve data invalid.



Air Conditioning Synoptic

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Cabin Pressure Control System

The Cabin Pressure Control System (CPCS) controls how much air can go out of the airplane. This helps to keep the airplane cabin altitude at 6,000 feet (1,829 meters) Mean Sea Level (MSL) in cruise flight.

Description

The CPCS has these components:

- Valve Control Unit (VCU) (2)
- Outflow Valve (OFV) (2)
- Remote Sensor Unit (RSU) (2).

The forward VCU is in the forward Electronic Equipment (EE) compartment.

The aft VCU is in bulk cargo.

Each VCU has two control channels and two internal cabin pressure sense transducers. Each VCU also has an RSU near it. The RSUs are a backup cabin pressure sensor.

The forward OFV is on the left side, outboard of forward cargo.

The aft OFV is on the right side, aft of bulk cargo.

Each OFV has three electric motor actuators. Two actuators are controlled by the two VCU channels. One actuator gets control from the pilots in manual mode.

Operation

In automatic mode, the VCUs control their OFVs to pre-pressurize for flight. This helps to prevent pressure bump in the cabin for takeoff and landing.

In climb and descent, the VCUs control the OFVs to maintain a comfortable cabin altitude rate change compared to airplane altitude rate change.

In cruise flight, the VCUs control the OFVs to maintain a stable cabin altitude.

In manual mode, the VCUs electronically disconnect the OFVs. The pilots control cabin altitude, climb, and descent rate changes using a toggle switch for each OFV.

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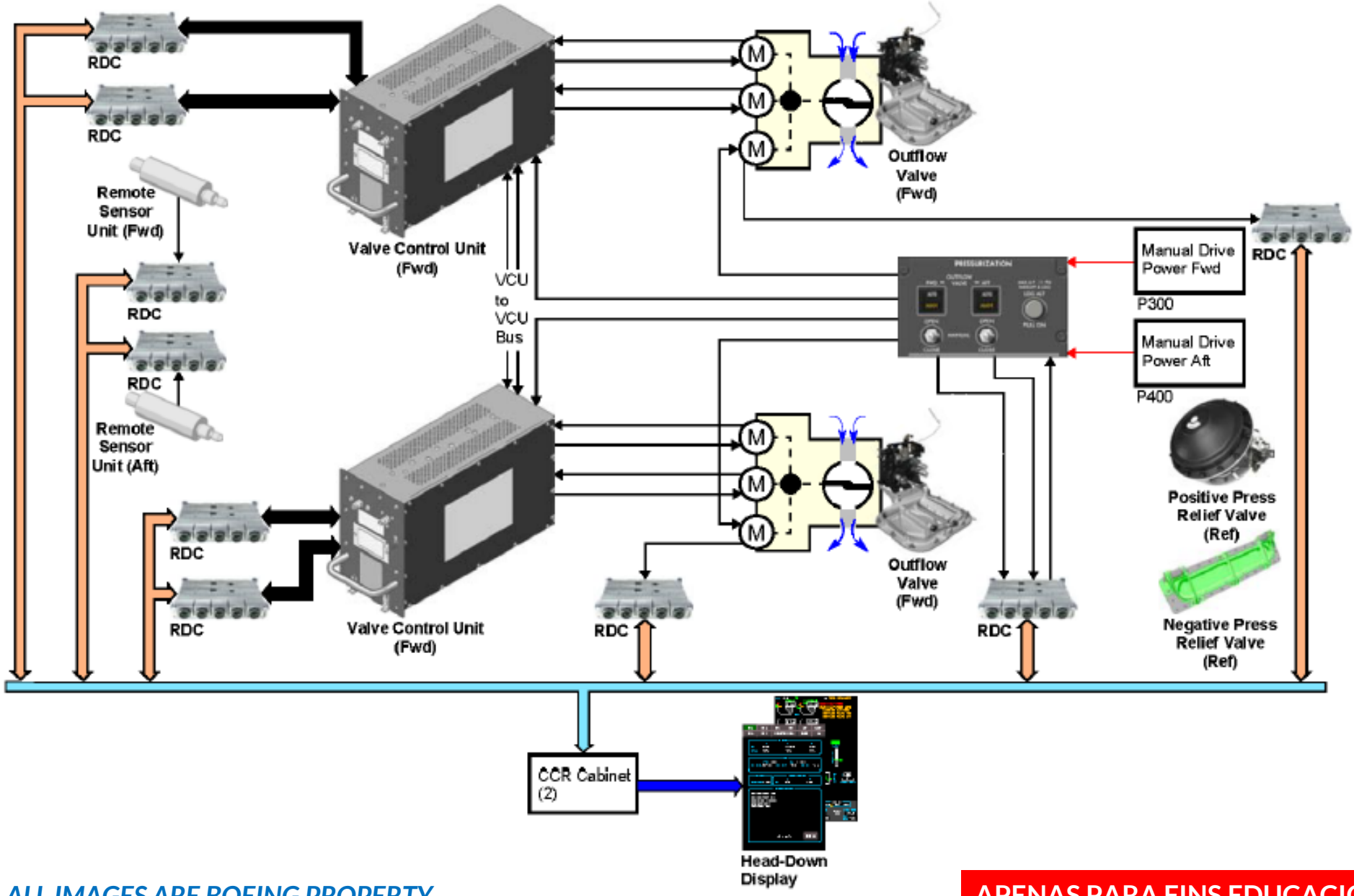

Cabin Pressure Control System

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Cabin Pressure Control System

The air conditioning control panel is on the P5 panel, above the first officer panel. These are the switches on the cabin pressurization control panel:

- FWD OUTFLOW VALVE (OFV) mode control switch
- AFT OUTFLOW VALVE mode control switch
- Forward and aft OFV manual control toggle switches
- LDG ALT manual selector switch.

Description

When the forward and aft OFV mode select switches are in AUTO, AUTO appears in the switch. When the mode select switches are in MAN, the amber MAN appears. The white AUTO does not appear.

The OFV manual control switches are spring-loaded to the center position.

The LDG ALT switch has two positions. In is automatic and out is manual control of landing altitude.

Operation

When the forward and aft OFV mode select switches are in AUTO, the Valve Control Units (VCU) automatically control their OFVs.

The VCUs use Flight Management Function (FMF) data, and Air Data Reference Function (ADRF) from the CCS. The VCUs also use internal cabin pressure transducer data, or Remote Sensor Unit (RSU) data for control of the Cabin Pressure Control System (CPCS).

When the mode select switches are in MAN, the VCUs electronically disconnect from their OFVs. The flight crew uses the toggle switches to manually control the OFVs.

In manual, the EICAS OFV shows an amber M for that indicator.

When the LDG ALT switch is pushed in, the VCUs use FMF navigation database information to set the landing altitude. The EICAS landing altitude appears white with a white AUTO.

When the switch is pulled out, the flight crew manually selects landing altitude by turning the switch knob clockwise or counter-clockwise. In manual, an amber MAN appears next to the landing altitude.

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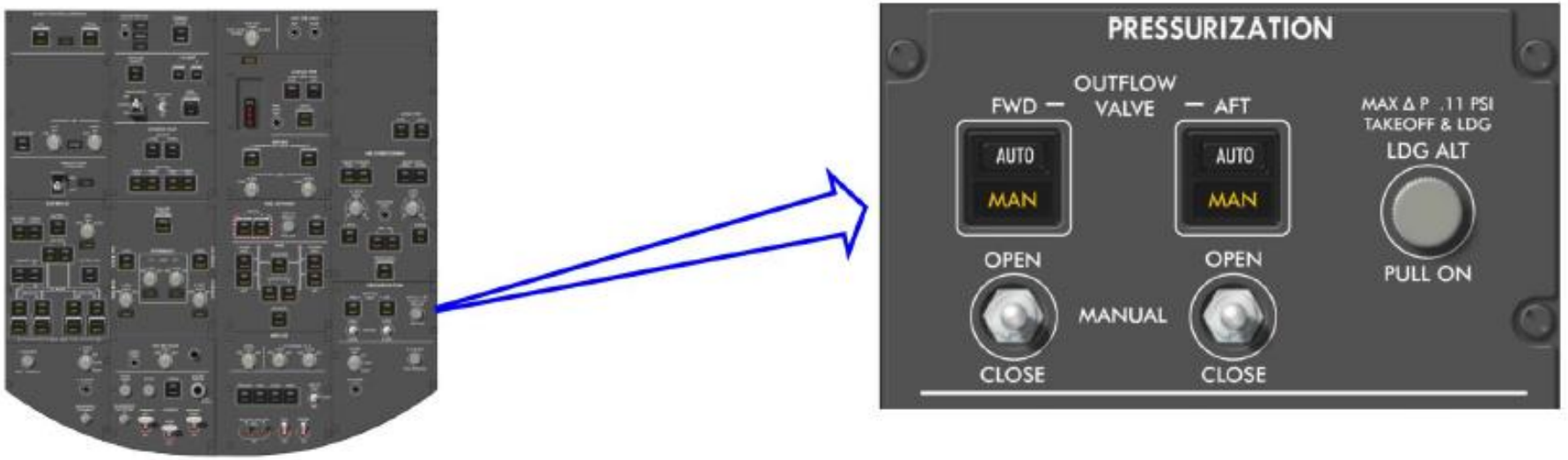
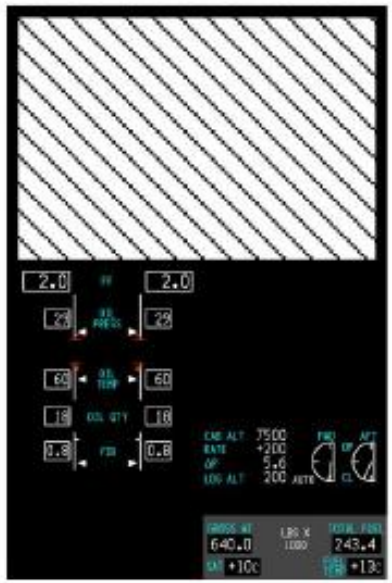
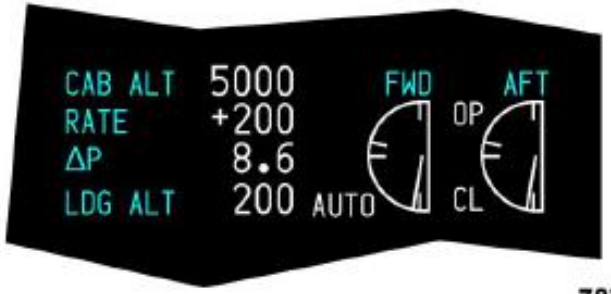
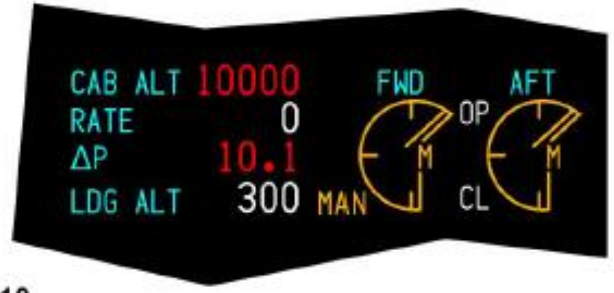




787-8





787-9/-10

Cabin Pressurization Control Panel

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PECS

The Power Electronics Cooling System (PECS) uses liquid coolant to cool high power, high temperature equipment in the aft Electronic Equipment (EE) compartment. PECS also cools the Motor Controllers (MC) and Supplemental Cooling Unit (SCU) components of the Integrated Cooling System (ICS).

The PECS uses a 60/40 percent mix of propylene glycol and deionized water for the coolant.

Description

There is a left loop and a right loop in the PECS. Each of the loops has these components:

- Pump package
- Liquid Temperature Control Valve (TCV)
- PECS Heat Exchanger (HX)
- Liquid temperature sensors (2)
- Pressure sensor
- Liquid ICS/SCU supply Shutoff Valve (SOV)
- Lavatory/Galley Ventilation (LGV) HX.

The pump packages and TCVs are in the two main landing gear wheel wells. The PECS HXs are in the air conditioning pack bays. The ICS/SCU SOVs are in the aft EE compartment. The LGV HXs are in bulk cargo.

Operation

Control of PECS comes from hosted applications in the Common Core System (CCS). The PECS operates when the airplane has electrical power on.

Each pump package has two pumps. One pump operates and the other pump is backup. The primary pump becomes the backup pump with each new flight.

The CCS uses the liquid TCVs to control the coolant temperature to 85°F (29°C). The CCS uses the two temperature sensors to monitor coolant temperature.

At PECS power-up, the CCS uses level sensors in the pump package reservoirs for fluid level indication.

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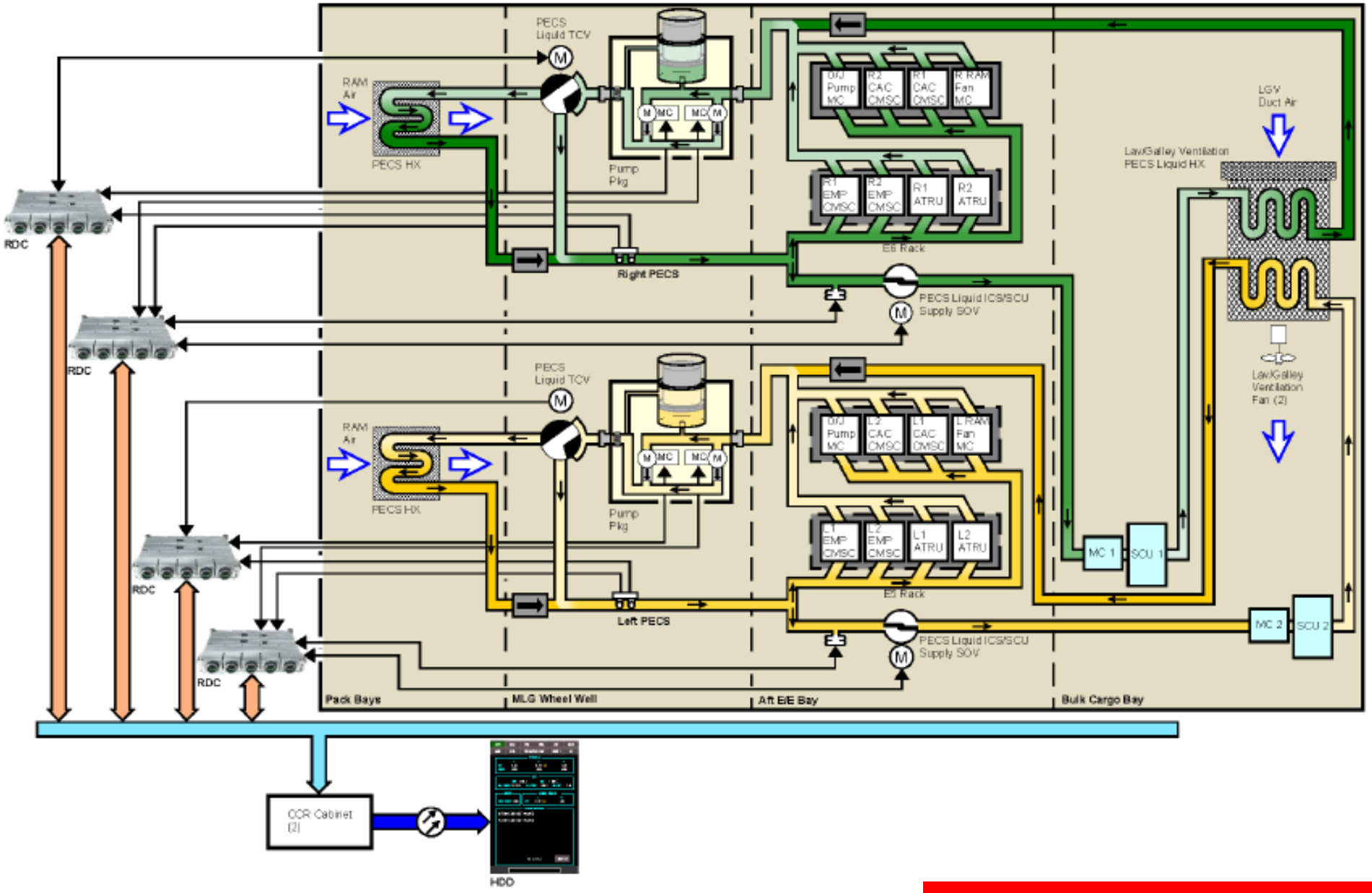

PECS

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ICS

The Integrated Cooling System (ICS) provides galley cooling units with cold fluid. The ICS can also lower the temperature of the air for the lower recirculation systems.

The ICS has these components:

- ICS pump package
- ICS liquid diverter valve
- Temperature sensors (6)
- Supplemental Cooling Units(SCU)
- Galley Cooling Units (GCU)
- Auxiliary ICS Reservoir (787-10 only).

The ICS pump package is in the right main landing gear wheel well.

The liquid diverter valve is in the right air conditioning pack bay. The temperature sensors are in the ICS liquid coolant line. The SCUs are in the bulk cargo compartment. The GCUs are above the galleys that have cooling carts.

The ICS pump package has a reservoir and two motor-controlled pumps. While one pump is on, the other pump is standby.

The ICS coolant is made of a mixture of propylene glycol and deionized water.

The 787-10 has an additional Auxiliary ICS Reservoir in the right hand side wheel well, above the ICS Pump package. It is used mainly during hot weather ground operations.

Operation

The ICS control is automatic. Hosted applications in the Common Core System (CCS) operate the ICS. The ICS operates anytime the airplane has electrical power. The CCS sets the temperature of the ICS coolant.

The ICS pump sends coolant through the SCUs in series The SCUs are closed-circuit, vapor cycle refrigeration units. The SCUs progressively cool the coolant to make it cold for the GCUs.

As the ICS pump moves the fluid from the SCUs, fluid goes to the GCUs. The CCS controls diverter valves in each GCU. The diverter valve controls coolant flow through the GCU Heat Exchanger (HX). A fan moves air through the HX where the coolant makes the air cold. This cold air goes through the carts in the galley, keeping the carts cool.

After going through the last galley, the coolant goes back toward the ICS pump package. The CCS monitors the temperature of the coolant after the last galley. If the coolant temperature is too high, the CCS controls a diverter valve to send the coolant through the lower recirculation system HXs.

The operation of the ICS on the 787-9 and 787-10 is similar to the 787-8.

The design of the 787-9/10 ICS system is different from the 787-8.

The 787-8 connects each of the GCUs in series, on the 787-9 and 787-10 the GCUs connect in parallel with a return line through a diverter valve to the upper recirc heat exchanger and back to the pump package.

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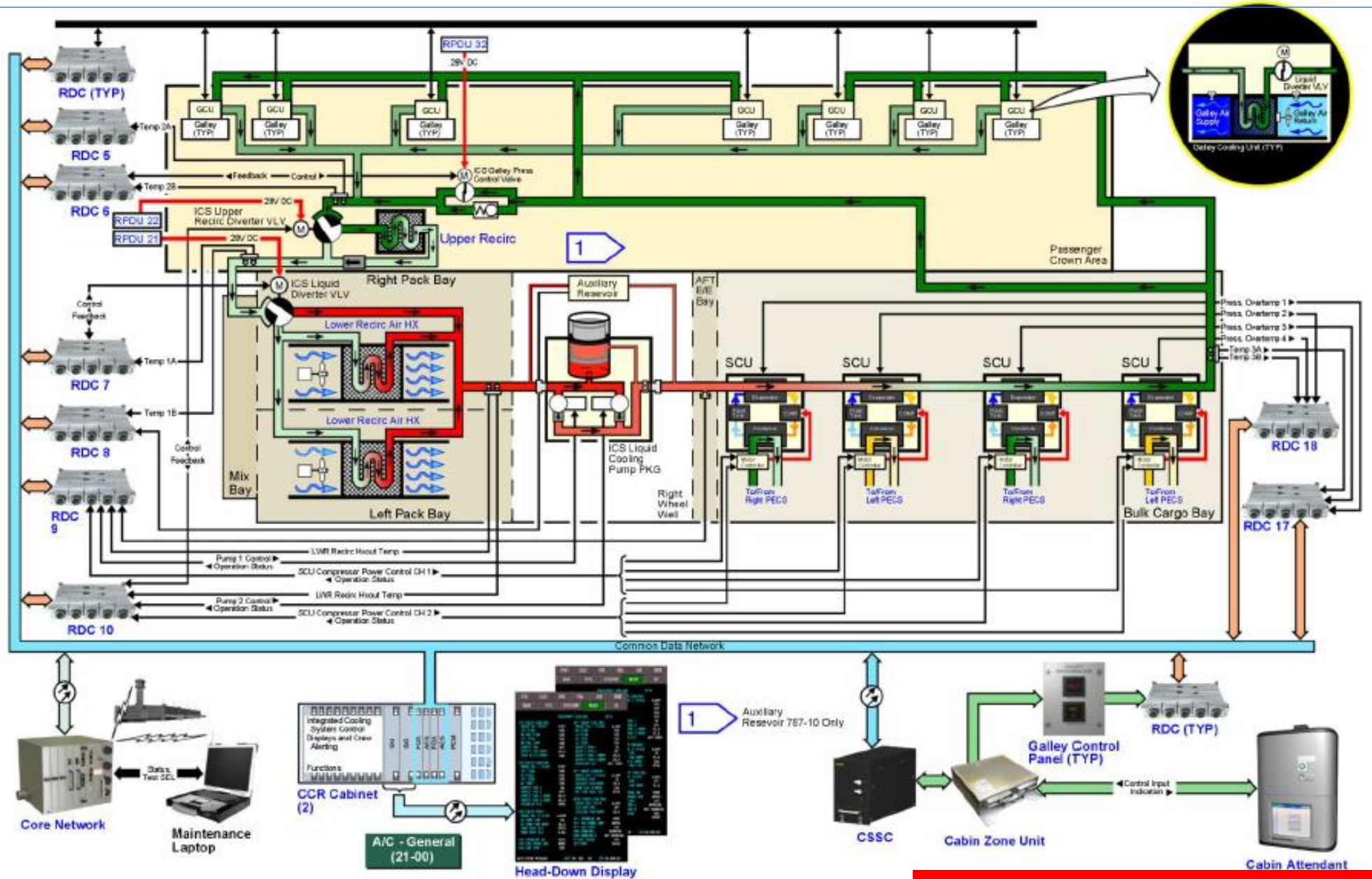

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ICS

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