ICE AND RAIN

ICE AND RAIN SYSTEM COMPONENT LOCATION

SYSTEM OVERVIEW

The ice and rain protection system enables unrestricted operation in icing conditions and heavy rain.

For anti-icing, hot air or electrical heating protects critical areas of the aircraft.

The different subsystems of the ice and rain protection system are:

- wing ice protection,
- engine air intake ice protection,
- probe ice protection,
- windshield ice and rain protection,
- drain mast ice protection,
- water and waste system ice protection (some are optional).
- visual lighted ice detection,
- electronic ice detection system (optional),

WING ANTI ICE PROTECTION

Hot air from the pneumatic system is provided for the anti-icing of the three outboard leading edge slats (3, 4 and 5) of each wing.

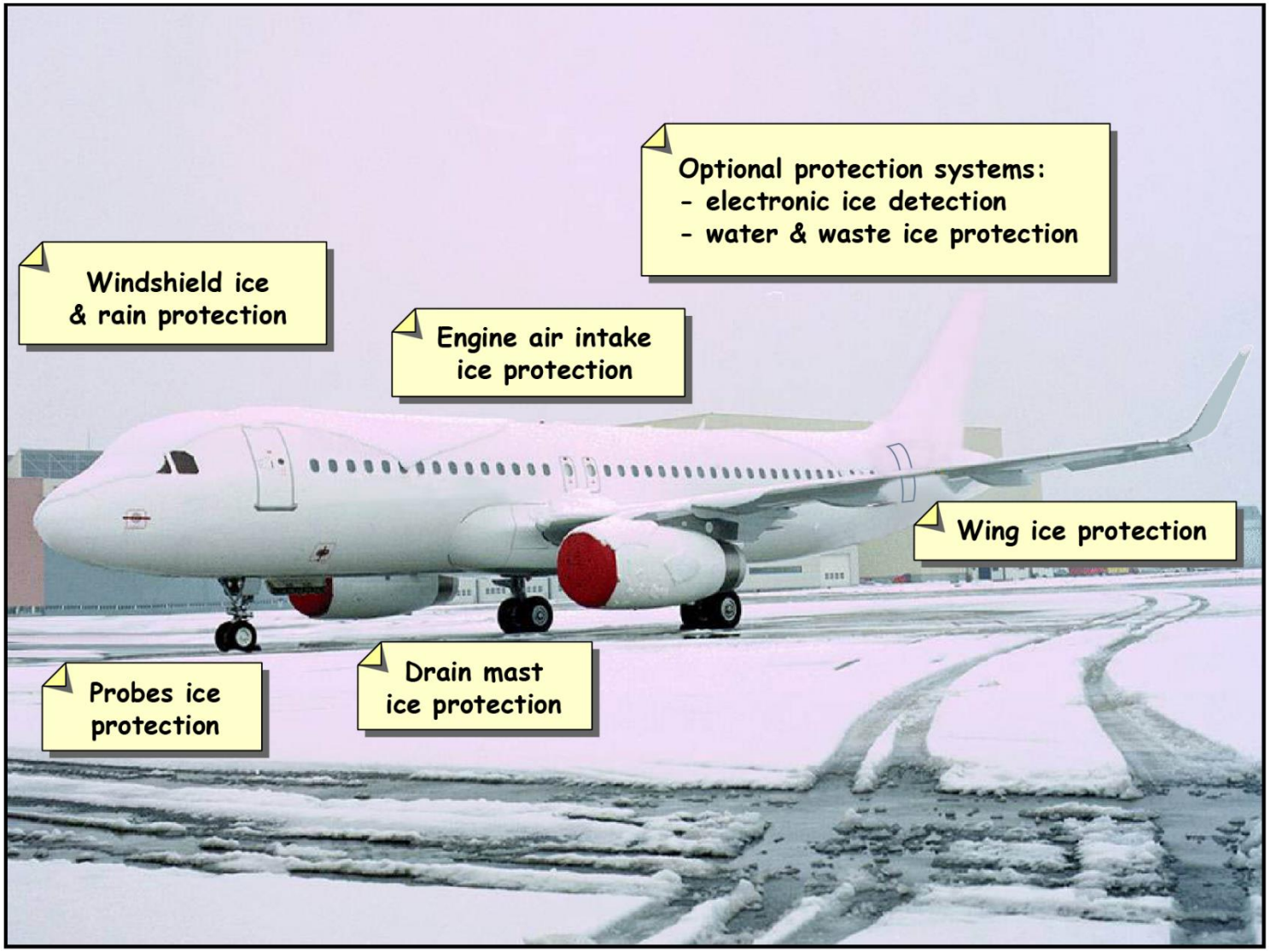
Bleed air from the engines or the APU is supplied to each wing through a pressure regulating and shut off valve.

Wing anti-ice supply to both wings is controlled by a single pushbutton switch on the overhead ANTI ICE panel.

ENGINE AIR INTAKE ANTI ICE PROTECTION

Each engine air intake is protected from ice by an independent air bleed supply from the high-pressure compressor of that engine.

The air is supplied through the engine air intake anti-ice valve. Engine anti-ice is manually selected by the crew and is available in flight or on the ground with the engine running.


Optional protection systems:
- electronic ice detection
- water & waste ice protection
Windshield ice & rain protection
Engine air intake ice protection
Wing ice protection
Probes ice protection
Drain mast ice protection

PROBE ICE PROTECTION

To provide reliable information for the air data systems, the air data probes are heated AUTOMATICALLY when at least one engine is running. Ice protection of the Angle Of Attack (AOA) sensors, pitot probes, static ports, and Total Air Temperature (TAT) probes is achieved by electrical heating.

The PROBE/WINDOW HEAT pushbutton switch (normally in the AUTO position) may be used to select the probe heating ON with the engines shut down.

WINDSHIELD ANTI ICE PROTECTION

Electrical heating is provided for windshield anti-icing and cockpit side window de-fogging.

The front windshields and side windows are heated AUTOMATICALLY when at least one engine is running.

The PROBE/WINDOW HEAT pushbutton switch (normally in the AUTO position) may be used to select the window heating ON with the engines shut down.

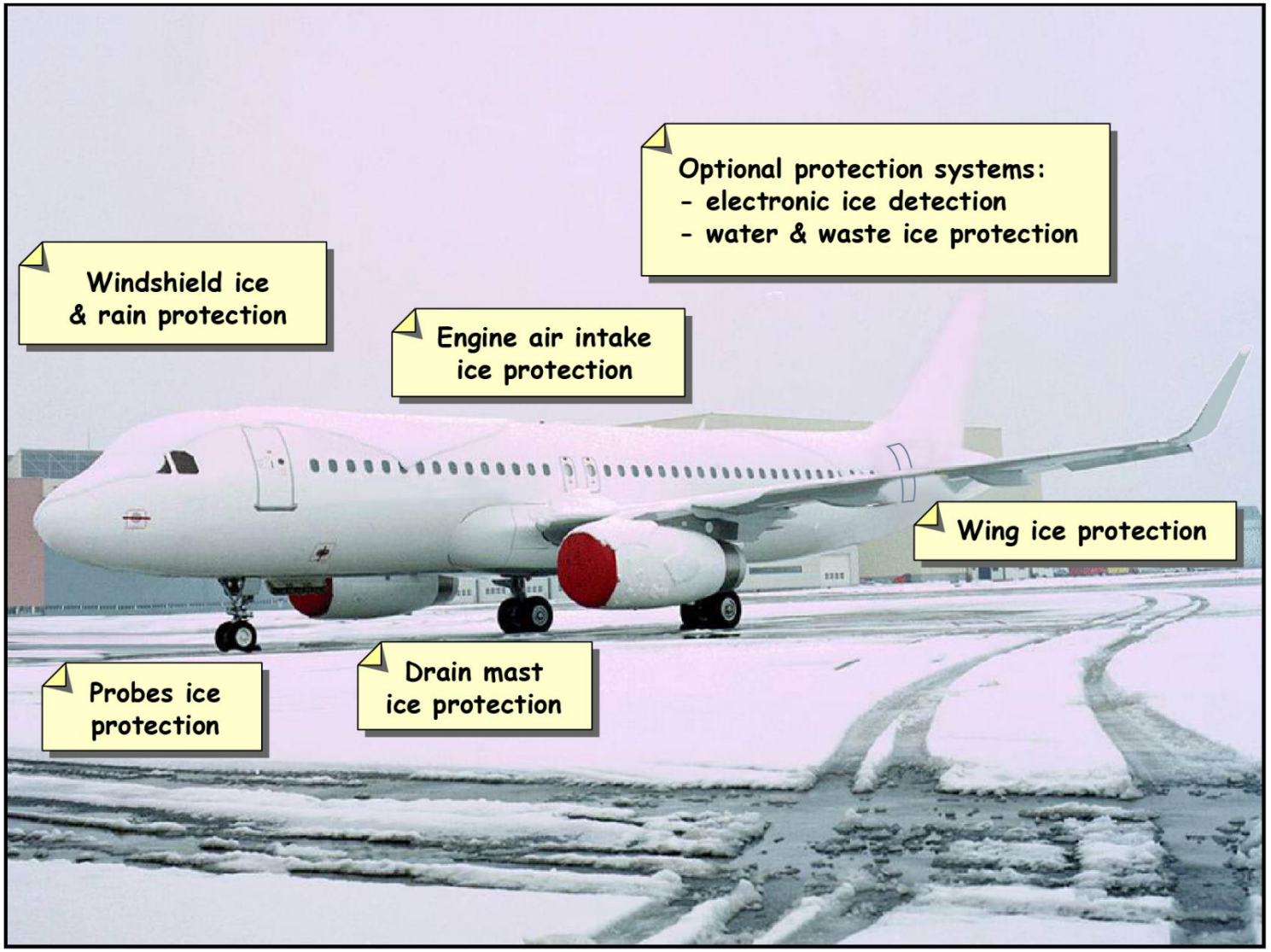
DRAIN MAST ICE PROTECTION

When the electrical system is powered, the waste water Drain Masts are also electrically heated. The Drain Mast Heating is switched ON when the temperature is below a specific value.

It is not always in operation.

There are two Drain Masts located on the lower fuselage forward and aft sections.

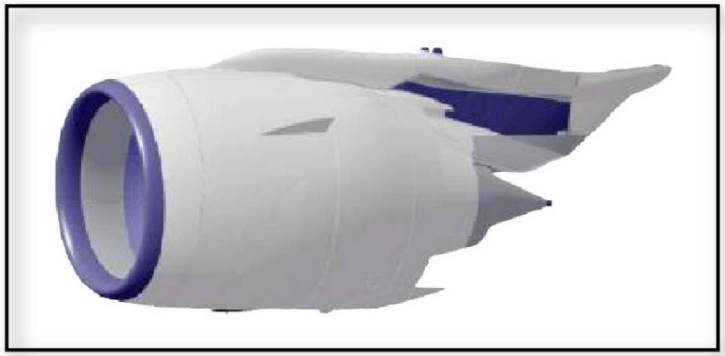
Two Control Units, located in the cargo compartments, control the Heating of the FWD and AFT Drain Masts.


Optional protection systems:
- electronic ice detection
- water & waste ice protection
Windshield ice & rain protection
Engine air intake ice protection
Wing ice protection
Probes ice protection
Drain mast ice protection

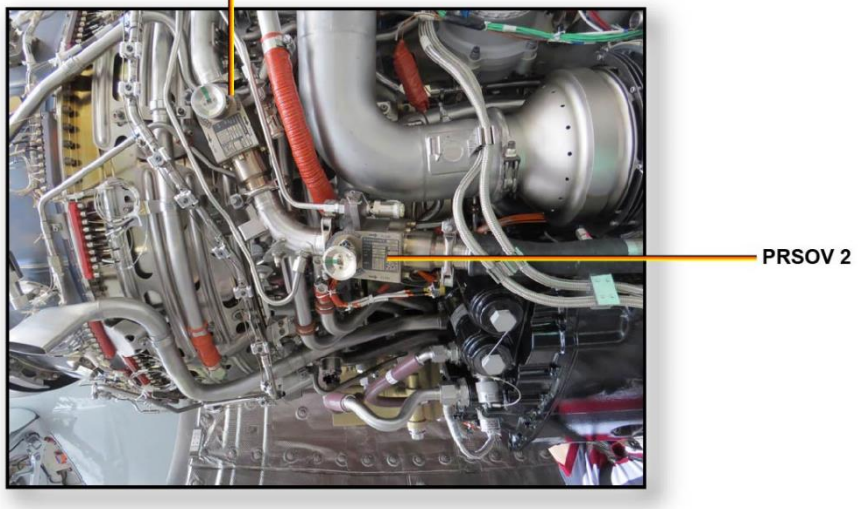
ENGINE AIR INTAKE ICE PROTECTION - NEO

Two engine anti-ice valves are installed on the lower right-hand side of the engine core.

PW1100G



CFM LEAP



ENGINE ANTI ICE SYSTEM (PW1100G)

USERS

The Nacelle Anti-Ice (NAI) System is designed to prevent ice formation on the engine inlet which could affect the engine operation.

The engine air intake is heated during icing conditions using its related bleed air.

The hot air is then discharged overboard.

SOURCE

Hot air for the Nacelle anti-ice system is supplied by a dedicated HP Compressor (HPC) bleed:

on the CFM-LEAP, 7th stage,

on the PW1000G, 6th stage.

VALVE

The NAI System is controlled and monitored by the (Propulsion Control System (PCS) (Engine Electronic Controller (EEC) and Engine Interface Unit (EIU)).

Each engine NAI System consists of two electrically controlled, pneumatically operated Pressure Regulating and Shut-Off Valves (PRSOV).

The EEC energizes the solenoid to CLOSE the PRSOV.

Therefore, in case of loss of electrical power supply, the valves will go fully open provided the engine bleed air supply pressure is high enough.

In the absence of air pressure, the valve is spring-loaded to the closed position.

CONTROLS

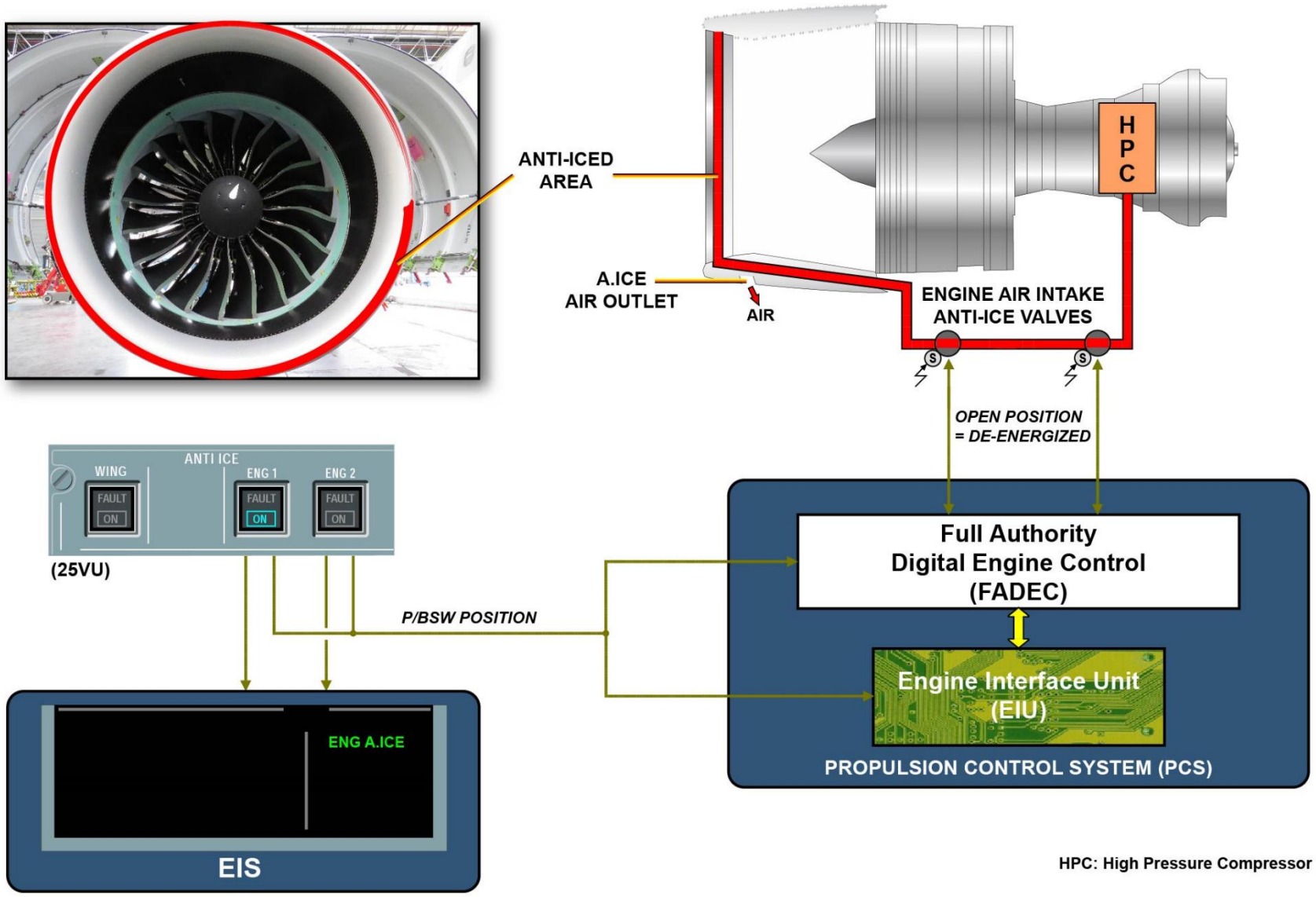
When the ENG ANTI ICE P/BSW is selected ON, signals are sent to EEC for controlling the valves and to the EIU to calculate the bleed decrements.

ECAM PAGE

If at least one of the two engine air intake anti-ice protection systems are selected ON, a message appears in green on the upper ECAM right MEMO.

The EEC monitors the valve position through transducers and processes them to generate necessary indications and warning through the Flight Warning System (FWS).

The FAULT indication in the PB S/W is activated by the PCS.


ANTI-ICED
AREA
A.ICE
AIR OUTLET
AIR
H
P
C
ENGINE AIR INTAKE
ANTI-ICE VALVES
OPEN POSITION
= DE-ENERGIZED
ANTI ICE
WING
ENG 1
ENG 2
FAULT
ON
(25VU)
P/BSW POSITION
Full Authority
Digital Engine Control
(FADEC)
Engine Interface Unit
(EIU)
PROPULSION CONTROL SYSTEM (PCS)
ENG A.ICE
EIS
HPC: High Pressure Compressor

ENGINE AIR INTAKE ICE PROTECTION SYSTEM (PW1100G)

NAI SYSTEM

Each engine air intake has its own independent Nacelle Anti-Ice (NAI) protection system.

NAI System uses the hot bleed air from a dedicated engine bleed port (6th stage High Pressure Compressor (HPC) for PW1100G).

This bleed air is lead to engine air inlet through a feed duct which passes along the RH side of the engine core and fan case.

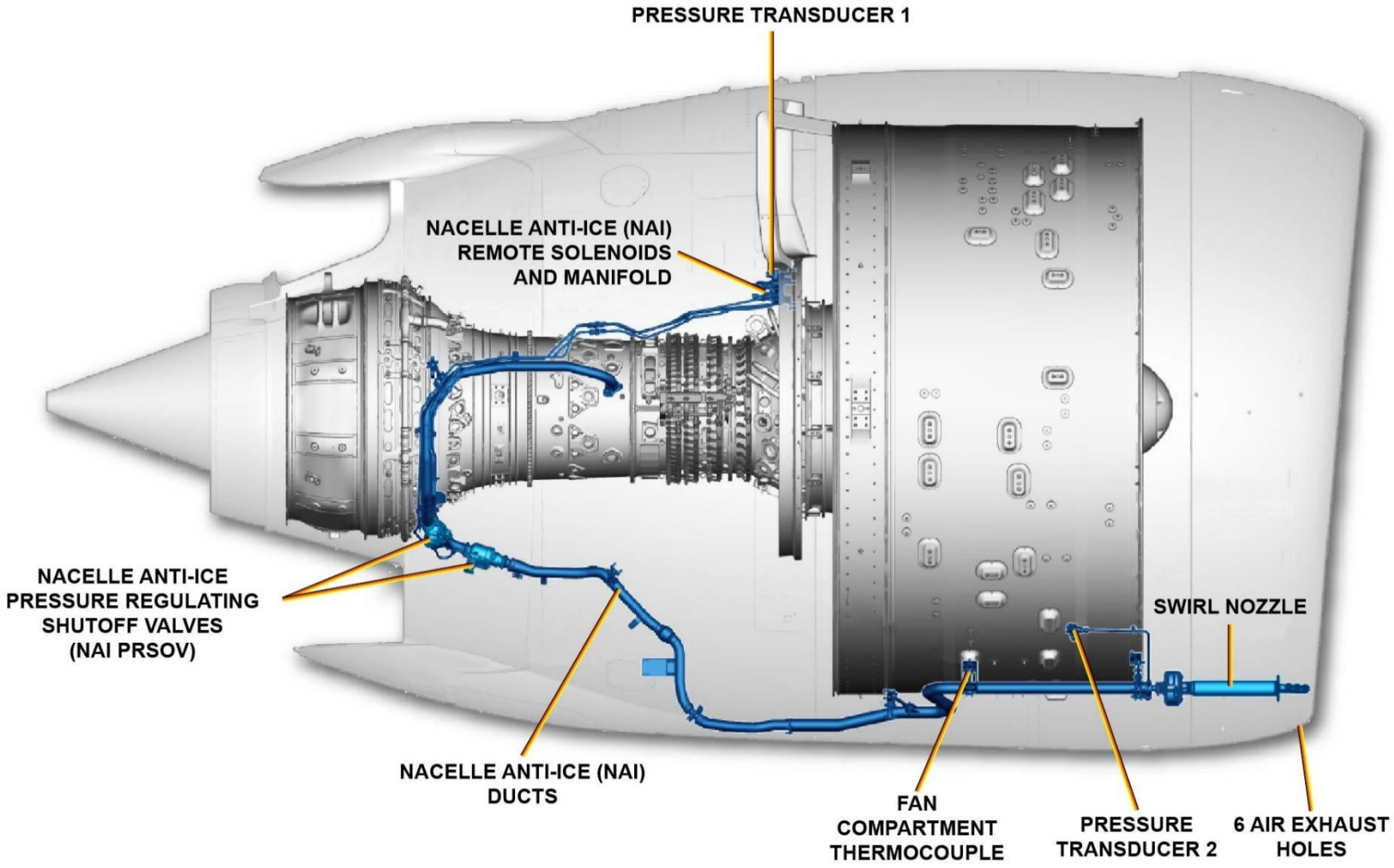
Each engine NAI system consists of one command P/B SW but two Pressure Regulating and Shut -Off Valves (PRSOVs) for good operability, two Pressure Transducers (PTs), temperature protection and supply ducts.

Both PRSOVs are located on the engine core, Right Hand (RH) side.

AIR INLET COWL

The air is released into the air intake lip (D-Duct) through a swirl system which mixes the air and injects it in a specific pattern for effective heating.

The airflow exits the air intake lip by a single exhaust grid at the bottom of the nacelle outside the fan which has 6 oval holes.


PRESSURE TRANSDUCER 1
NACELLE ANTI-ICE (NAI)
REMOTE SOLENOIDS
AND MANIFOLD
NACELLE ANTI-ICE
PRESSURE REGULATING
SHUTOFF VALVES
(NAI PRSOV)
SWIRL NOZZLE
NACELLE ANTI-ICE (NAI)
DUCTS
FAN
COMPARTMENT
THERMOCOUPLE
PRESSURE
TRANSDUCER 2
6 AIR EXHAUST
HOLES

PW1100G

PRSOV CONTROL AND OPERATION

The NAI system is controlled and monitored by the Propulsion Control System (PCS) (Engine Electronic Controller (EEC) and Engine Interface Unit (EIU)).

The EEC controls the PRSOV operation by energizing/de-energizing the solenoids.

PRSOV 1 is controlled by EEC Channel A and PRSOV 2 is controlled by Channel B.

Each PRSOV pneumatically regulates the downstream air pressure.

When the NAI PB S/W is selected to 'ON' position, the EEC de-energizes the solenoid valves of PRSOV to OPEN the valves.

Only when both the valves are open the bleed air is fed to the engine intake lip.

The PRSOV 1 regulates the upstream pressure then in cascade PRSOV 2 the downstream pressure at different threshold.

MONITORING

The EEC does a detailed monitoring of the PRSOVs with two PTs (PT1 & PT2) located downstream each PRSOV.

PT1 is located in between the PRSOVs in the core engine area.

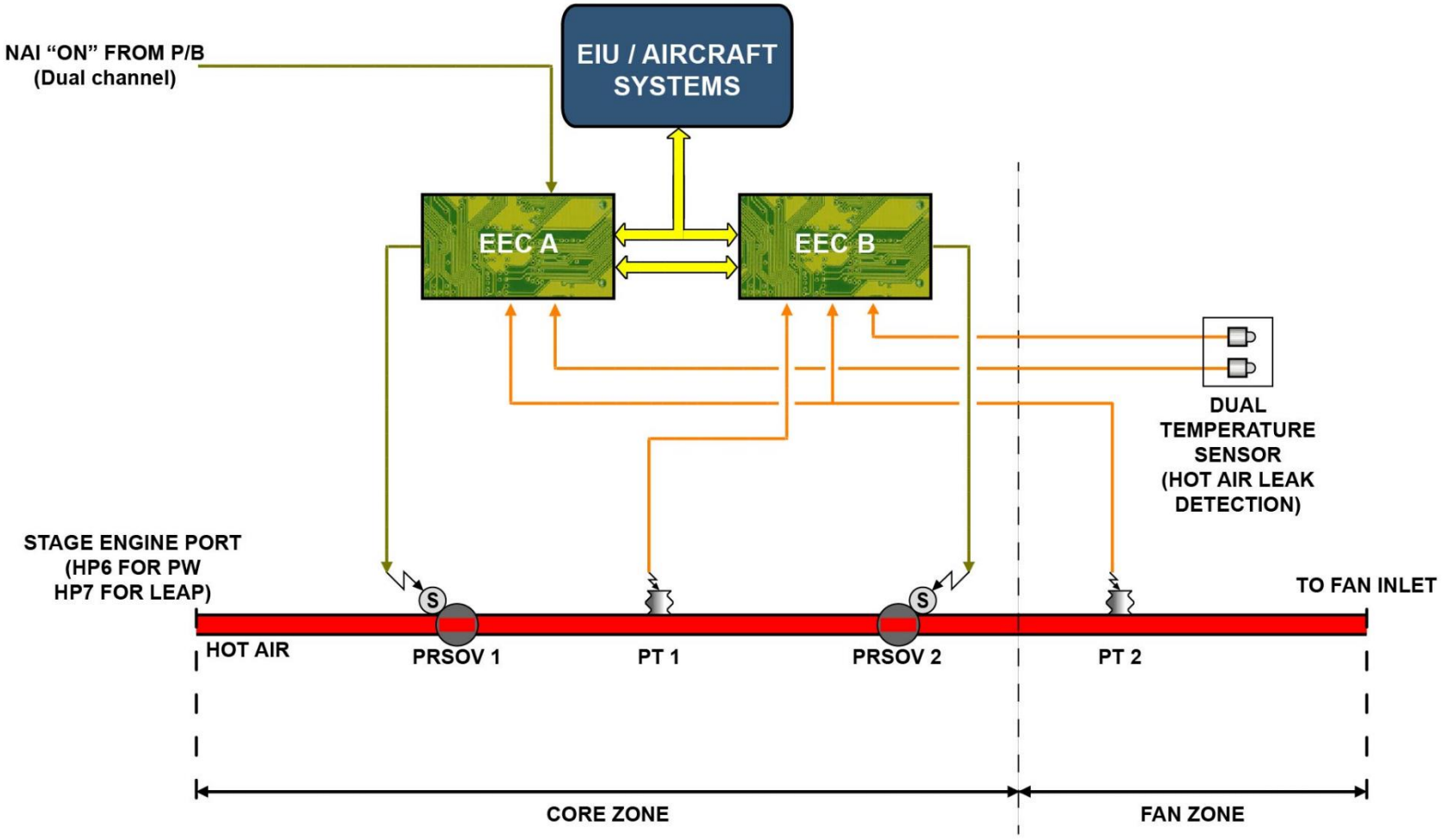
It gives the feedback to channel B only and is used for trouble shooting.

PT2 is located downstream of PRSOV 2 in the fan case.

It gives the feedback to both the EEC channels for monitoring function in case of single failure of EEC channel.

A dual temperature sensor located in the fan case, provides the EEC (one per channel) with the fan compartment temperature measurement for NAI leakage detection.

When the engine is running and a "Hot Air Leakage" event is detected, the EEC energizes PRSOVs solenoids, which provide the isolation function.



EEC: Engine Electronic Controller
EIU: Engine Interface Unit
NAI: Nacelle Anti-Ice
PRSOV: Pressure Regulating Shut-Off Valve
PT: Pressure Transducer

ENGINE ANTI ICE P/BSW

The P/B SW sends a discrete signal to the EEC to operate the PRSOVs.

The P/B SW position and the opposite engine P/B SW position are monitored by the EIU for computing the bleed decrements.

The "FAULT" light is triggered by the EIU based on the input from EEC.

It appears when the engine is running and NAI is failed in OPEN or CLOSED. It also appears in case of monitoring fault.

PCS (EEC and EIU)

The EEC controls the PRSOV to open when the P/B SW is set to ON.

The EEC monitors the position of the PRSOV by the two NAI transducers to trigger associated fault messages.

The System Data Acquisition Concentrator/Flight Warning System (SDAC/FWS), Flight Data Interface and Management Unit (FDIMU) and Centralized Fault Display Interface Unit (CFDIU) interfaces with the PCS.

FAILURE CONDITION

The failsafe position of the valves in case of EEC dual channel failure is OPEN.

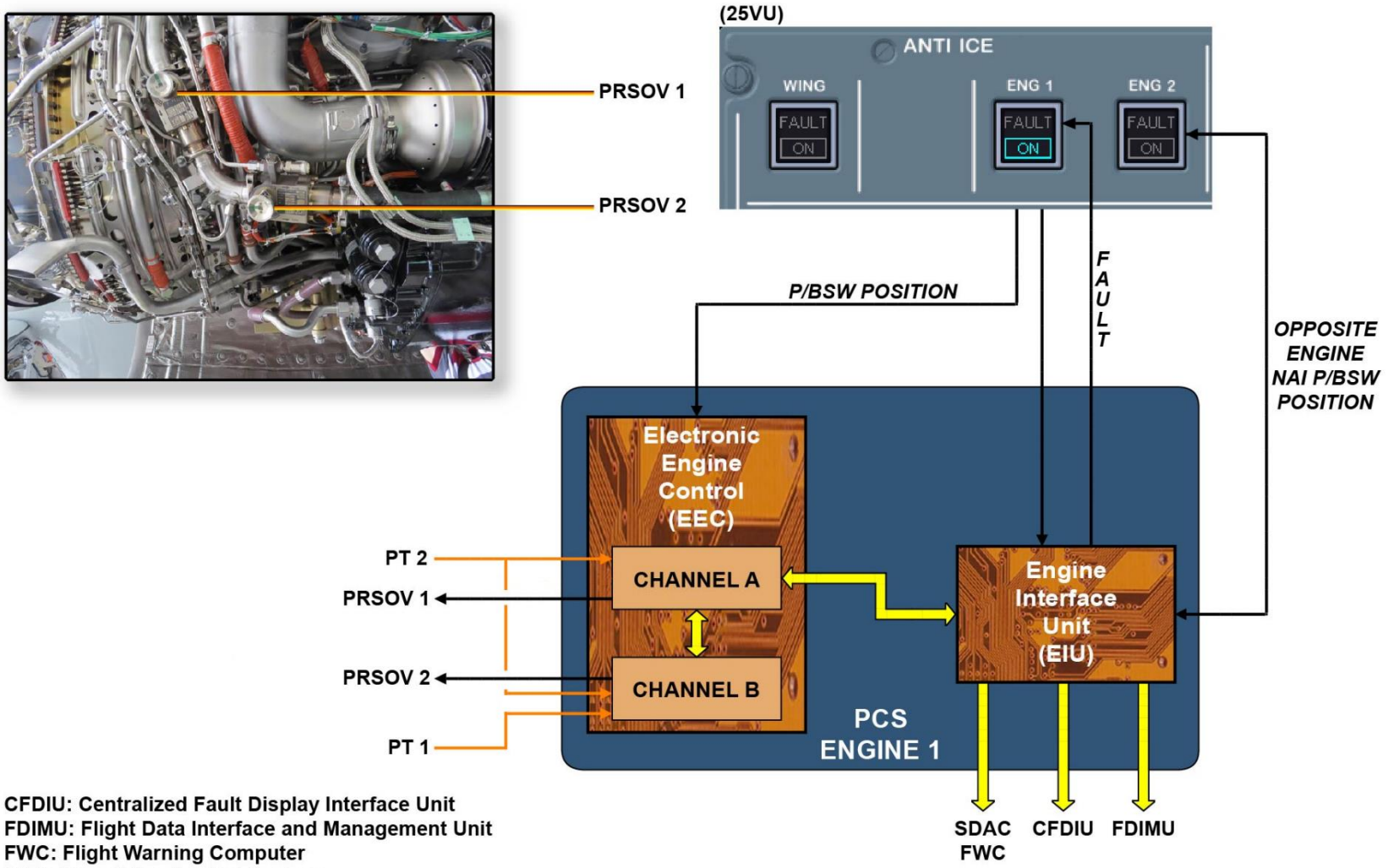
In case of a single valve failure, the corresponding valve being failed open, the anti-ice function is still available.

The two pressure Transducers (PT1 for core zone and PT2 for fan zone) monitors leak or burst scenarios and a dual fan case thermocouple helps in identifying over temperature conditions due to leaks or burst.

The EEC monitors the same and generates warning messages to the FWS.

Master Minimum Equipment List (MMEL) IMPACT:

In case of both NAI valve failures, dispatching with one of the two valves locked closed will not be possible.



CFDIU: Centralized Fault Display Interface Unit
FDIMU: Flight Data Interface and Management Unit
FWC: Flight Warning Computer
PCS: Propulsion Control System
PRSOV: Pressure Regulating Shut-Off Valve
PT: Pressure Transducer
SDAC: System Data Acquisition Concentrator

ICE AND RAIN PROTECTION SYSTEM D/O

Nacelle Anti-Ice (NAI) System

System components are located on the right side of the engine.

A list of components appears below.

Nacelle Anti-Ice Pressure Regulating NAI PRSOV Shutoff Valve (2)

Nacelle Anti-Ice remote solenoid (2) and manifold

Nacelle Anti-Ice pressure transducer (2)

Fan compartment thermocouple

Nacelle Anti-Ice ducts

Swirl nozzle

The NAI System is selected on/off by the pilot, usually when operating in icing conditions.

When selected ON, the system directs 6th Stage High Pressure Compressor air to the inlet cowl through a series of NAI ducts.

Controlled by the EEC, the system is manually activated by the pilot on the ground or in flight via the engine NAI cockpit Push Button (P/B). Each engine has its own push button.

Each P/B through switch sends the command to each Electronic Interface Unit (EIU).

Pushbuttons have a bulb to warn the crew in case of system malfunction.

Pressure Regulating Shut-Off Valves (PRSOVs) allow the flow of HPC air to the inlet cowl.

Note: Only one PRSOV is closed at each cycle to reduce the number of utilization cycles.

The signal to activate PRSOVs is sent directly to Channel A of the EEC, and to the EIU, by a discrete signal from the NAI cockpit P/B.

The Channel A signal is then internally transferred to Channel B.

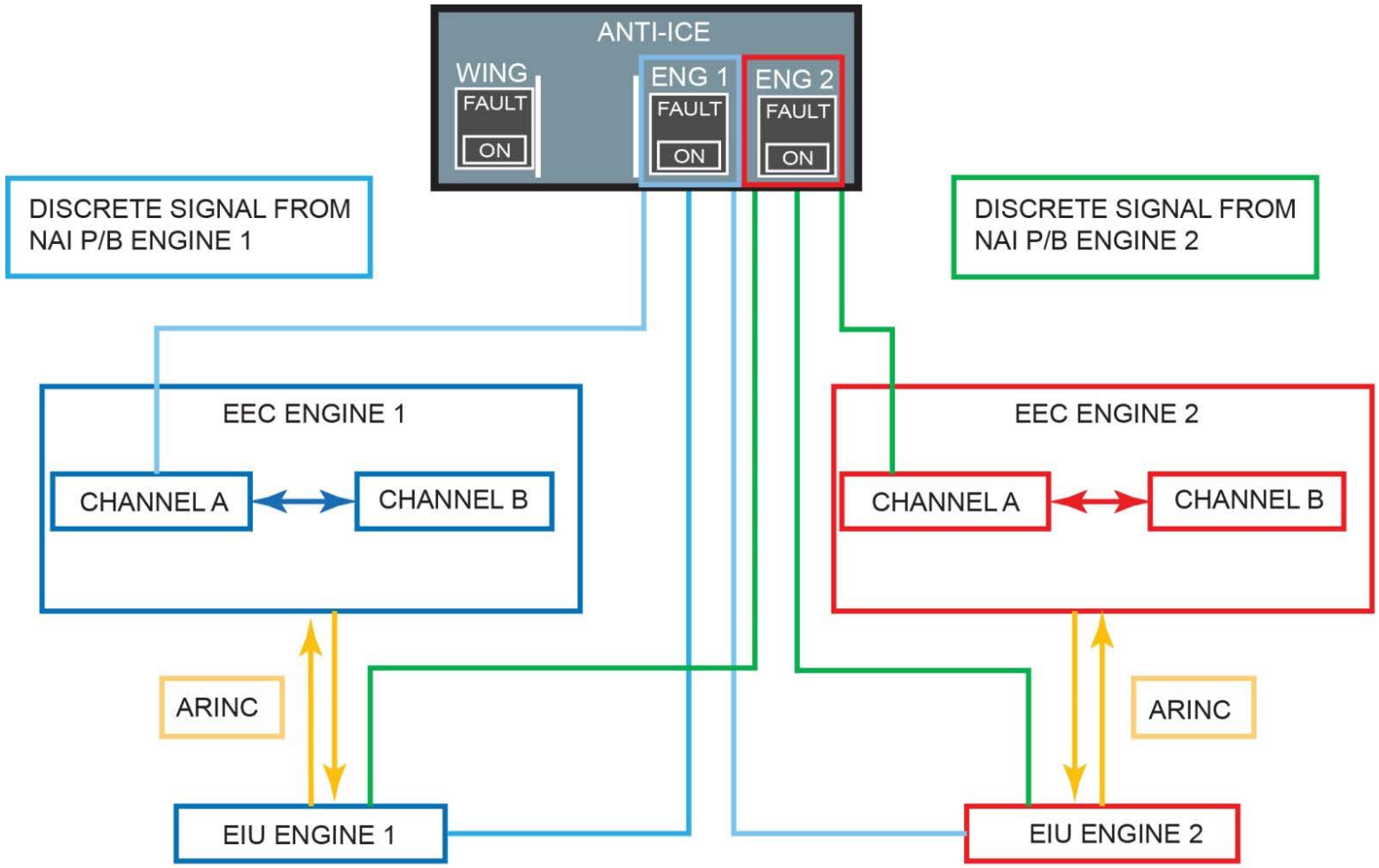
The EEC de-energizes the solenoid that opens one PRSOV and sends a signal to the EIU from both channels, indicating the anti-ice is ON.

The EIU then sends this signal to the cockpit.

When anti-ice is selected OFF by the NAI P/B, the EEC again internally transfers the signal to Channel B and will energize the solenoid to close the PRSOV.

One discrete signal informs the opposite EIU that engine thrust must be computed with NAI activated.

Channel A commands the upper PRSOV solenoid and Channel B commands the lower one.


ANTI-ICE
WING
FAULT
ON
ENG 1
FAULT
ON
ENG 2
FAULT
ON
DISCRETE SIGNAL FROM NAI P/B ENGINE 1
DISCRETE SIGNAL FROM NAI P/B ENGINE 2
EEC ENGINE 1
CHANNEL A
CHANNEL B
EEC ENGINE 2
CHANNEL A
CHANNEL B
ARINC
ARINC
EIU ENGINE 1
EIU ENGINE 2

Nacelle Anti-Ice Pressure Regulating Shutoff Valves (NAI PRSOV)

Purpose:

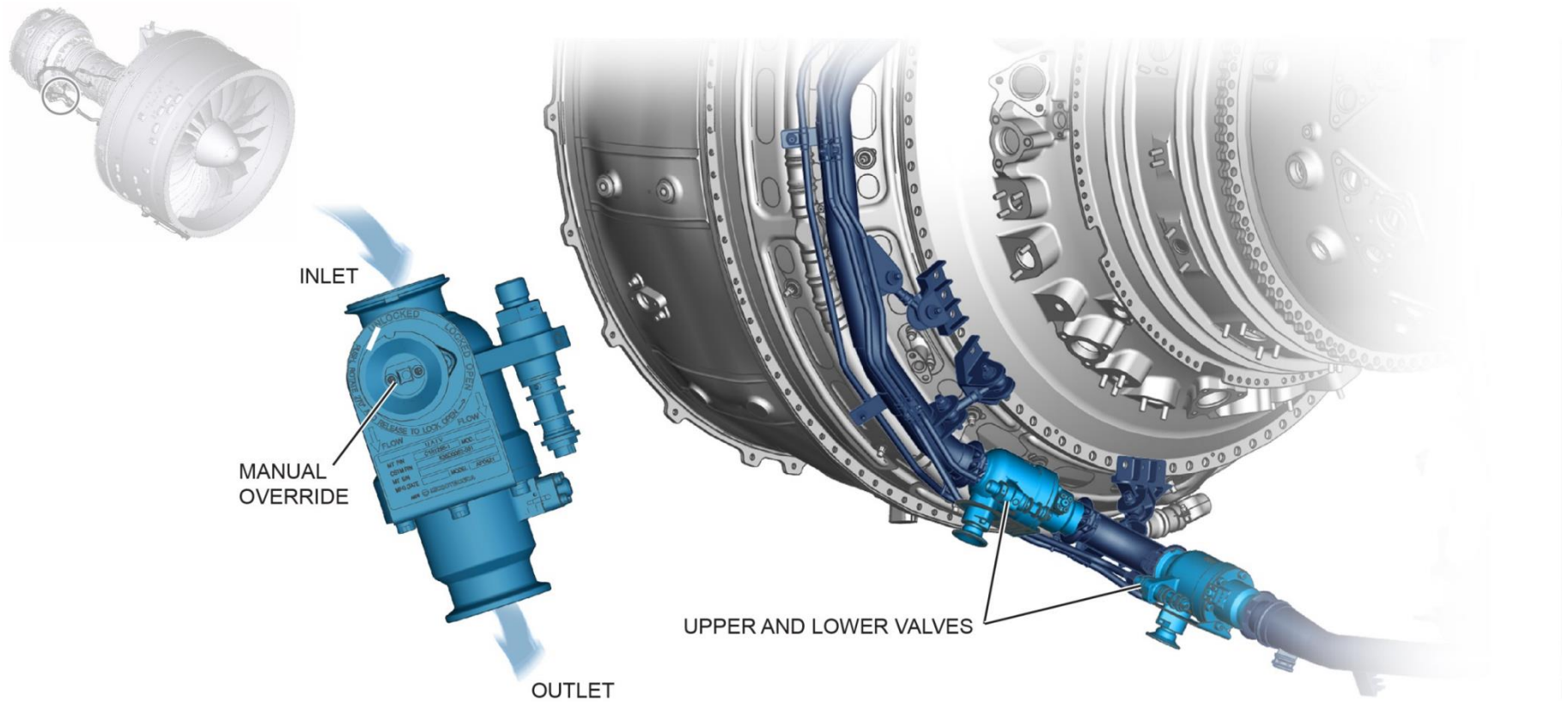
Upper and lower Nacelle Anti Ice Pressure Regulating Shutoff Valves operate in tandem to control pressure and airflow of HPC 6th Stage air used for inlet anti-ice.

Location:

The valves are mounted to the HPC case at 6:00 and 6:30.

Description:

When the NAI solenoids de-energize, HPC 6th Stage air flows through the NAI PRSOVs. When the solenoids energize, the flow of air stops.


INLET
MANUAL
OVERRIDE
OUTLET
UPPER AND LOWER VALVES

Nacelle Anti-Ice Pressure Regulating Shutoff Valves (NAI PRSOV)

Description (Cont.):

A list of hardware is shown below.

- Valve body housing
- Relief valve
- Relief valve spring
- Piston
- Control orifice
- Manual override cam
- Sense line port
- Reference chamber

Operation:

As the NAI solenoid de-energizes, and HPC 6th Stage air fills the reference chamber, the piston is compressed and forced to move to the open position.

This allows the HPC 6th Stage air to flow through the PRSOV.

When the NAI solenoid energizes, and HPC 6th Stage air is no longer supplied to the reference chamber, the piston moves to the closed position and the flow of air through the PRSOV stops.

Both upper and lower PRSOVs regulate pressure mechanically.

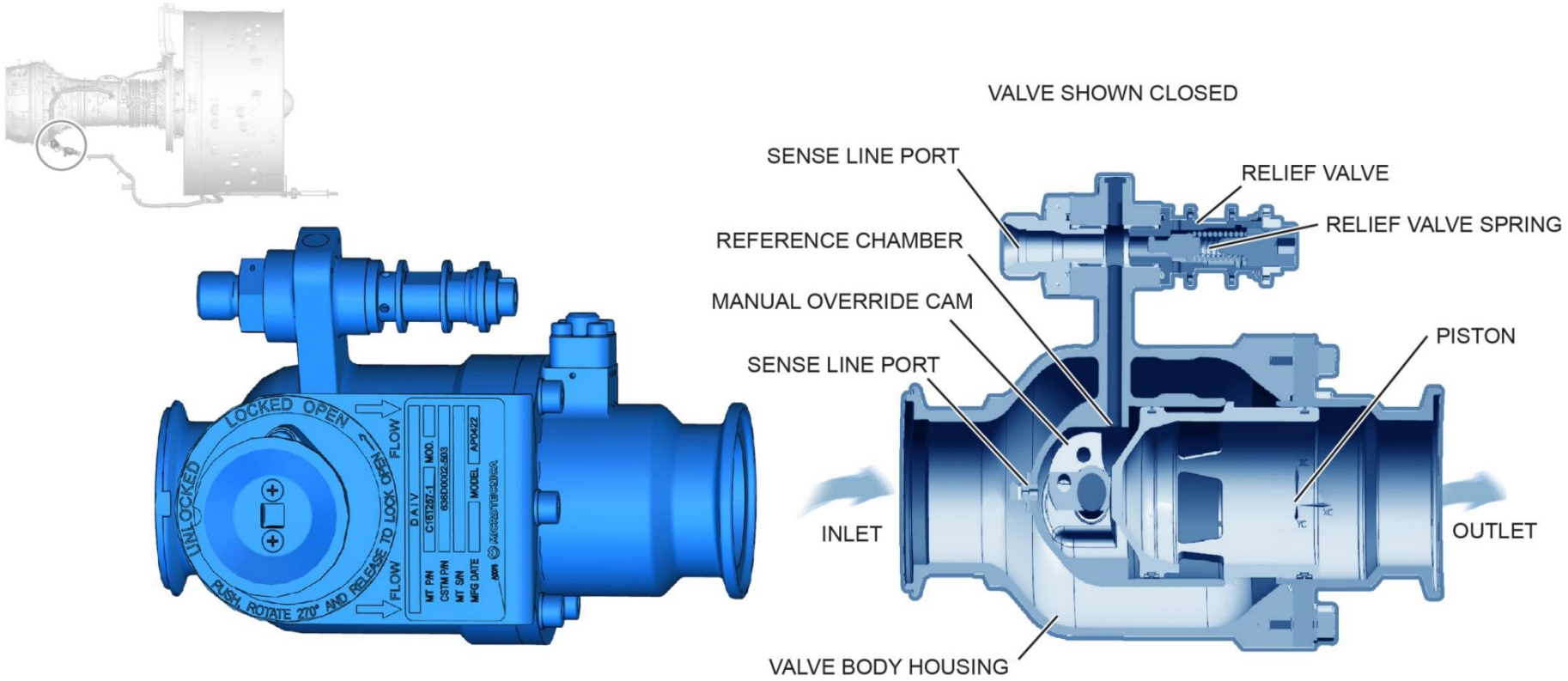
See the table for more information about working level pressures.

PRSOV	PSIG
Upper	104
Lower	80

Each valve contains a manual override feature that allows the valve to be locked open for Master Minimum Equipment List (MMEL) dispatch.

To do this, maintenance personnel access provisions in the Outer Fixed Structure (OFS) of the right thrust reverser door.

A 3/8-inch extension through the access port allows the valve to be rotated into the open position.

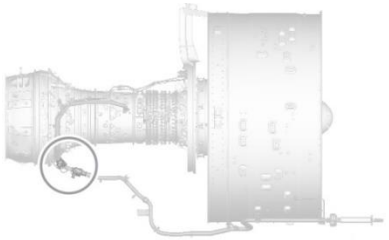

VALVE SHOWN CLOSED
SENSE LINE PORT
RELIEF VALVE
RELIEF VALVE SPRING
REFERENCE CHAMBER
MANUAL OVERRIDE CAM
PISTON
SENSE LINE PORT
INLET
OUTLET
VALVE BODY HOUSING
LOCKED OPEN
UNLOCKED
PUSH, ROTATE 270° AND RELEASE TO LOCK OPEN
FLOW
FLOW
D.A.I.V
MT P/N
C161267-1
MOD.
CSTM P/N
836D0002-503
MT S/N
MODEL
AP0422
MFG DATE

Nacelle Anti-Ice Pressure Regulating Shutoff Valves (NAI PRSOV)

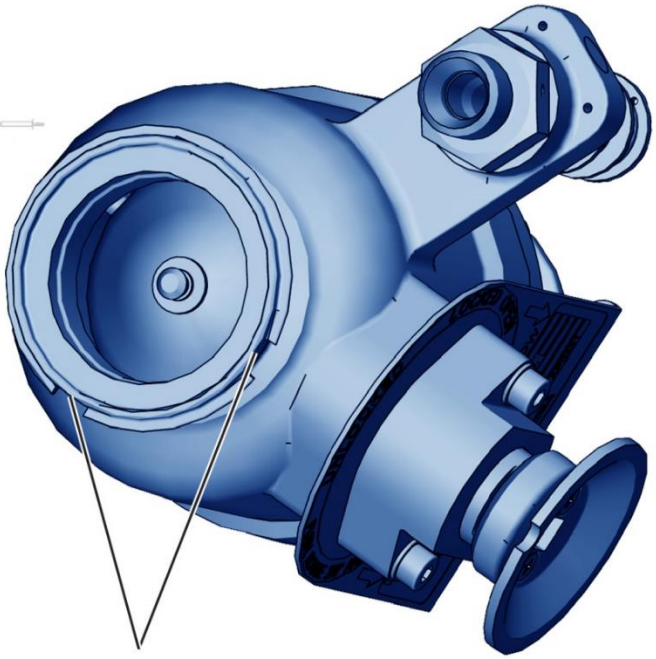
Operation (Cont.):

Upper and lower PRSOVs are not interchangeable due to regulating pressure differences.

A valve clocking feature distinguishes the ducts on the upper and lower valve types, preventing incorrect installation.

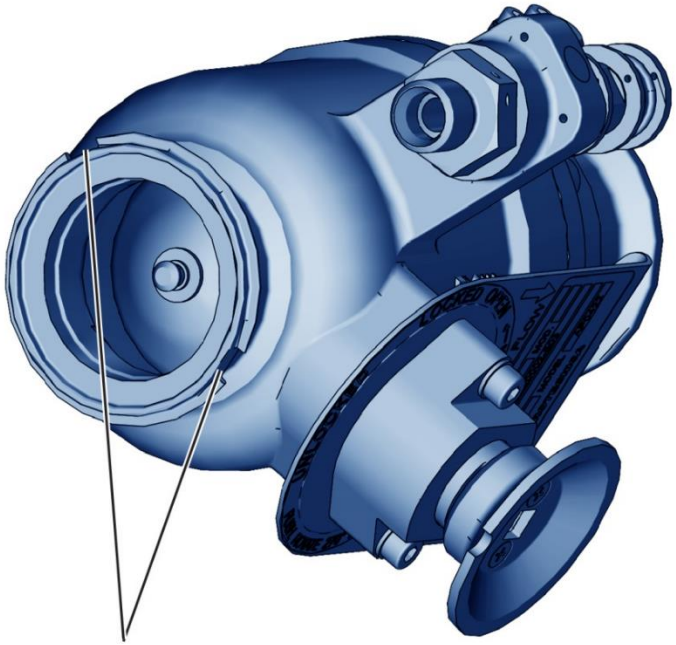


UPPER NACELLE ANTI ICE PRESSURE
REGULATING SHUTOFF VALVE (NAI PRSOV)



NAI DUCT CLOCKING FEATURE
90 DEGREE SEPARATION

LOWER NACELLE ANTI ICE PRESSURE
REGULATING SHUTOFF VALVE (NAI PRSOV)



NAI DUCT CLOCKING FEATURE
120 DEGREE SEPARATION

Nacelle Anti Ice (NAI) Remote Solenoids and Manifold

Purpose:

The NAI remote solenoids and manifold control the opening and closing of the NAI upper and lower PRSOVs.

Location:

The remote solenoid manifold is attached to the CIC firewall at 1:00.

Description:

The remote solenoid manifold supports two NAI solenoids. One solenoid is dedicated to the upper PRSOV and the other controls the lower one.

Operation:

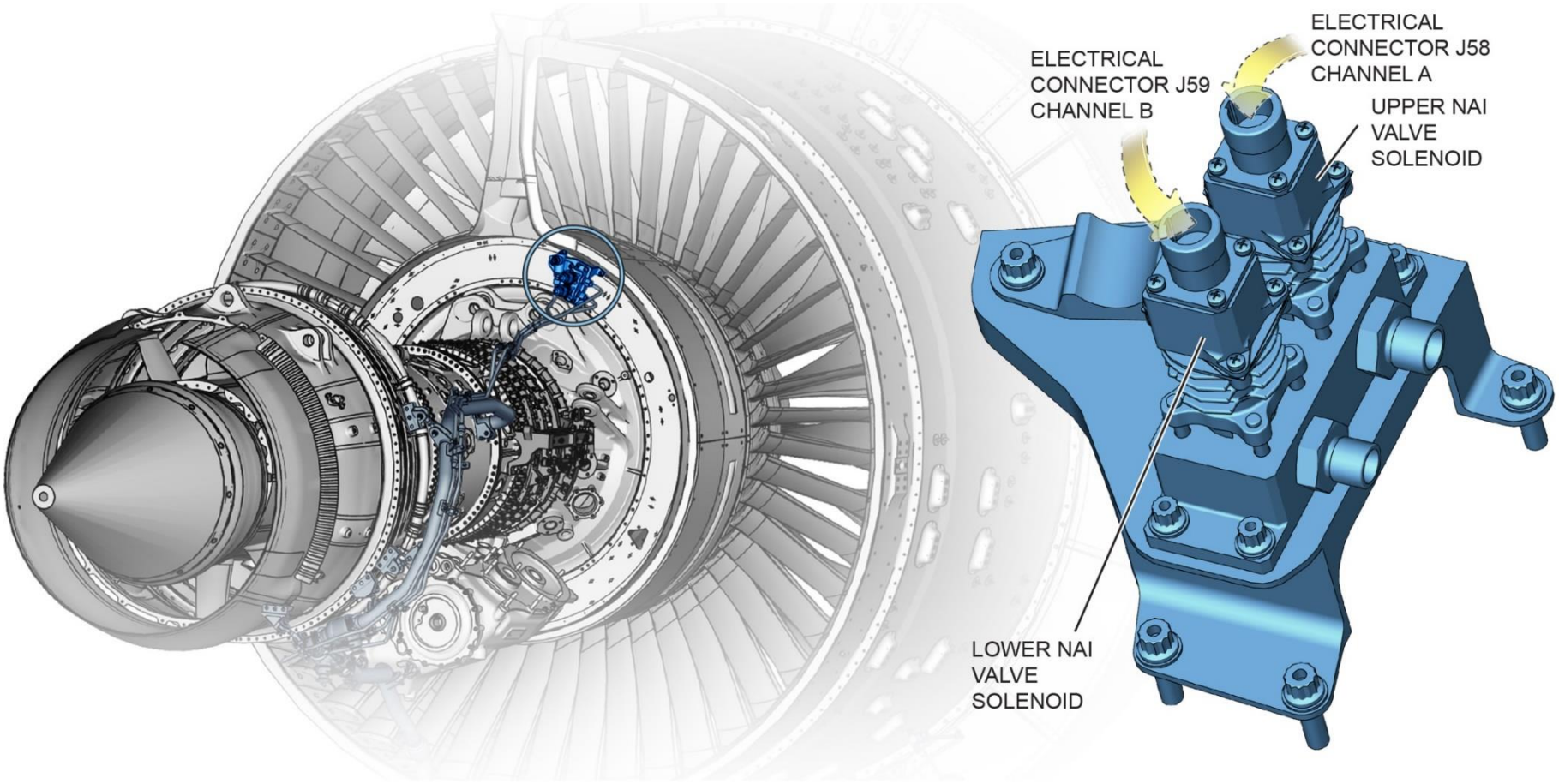
Each solenoid is a two-way device controlled by a 28Vdc signal from the EEC. Channel A controls the NAI solenoid for the upper PRSOV, and Channel B controls the lower one.

When the solenoid de-energizes, its inlet port opens, allowing HPC 6th Stage air to pressurize the PRSOV reference chamber.

This pushes the PRSOV piston into the open position.

When the solenoid energizes, HPC 6th Stage air pressure is blocked, depressurizing the reference chamber in the PRSOV.

This allows the PRSOV piston to return to the closed position and air flow pushes the piston closed.


ELECTRICAL
CONNECTOR J58
CHANNEL A
ELECTRICAL
CONNECTOR J59
CHANNEL B
UPPER NAI
VALVE
SOLENOID
LOWER NAI
VALVE
SOLENOID

Nacelle Anti Ice (NAI) Pressure Transducers

Purpose:

NAI pressure transducers monitor NAI duct pressure upstream and downstream of the NAI PRSOVs to determine their operating condition.

Location:

One transducer is located on the remote solenoid bracket mounted to the Compressor Intermediate Case firewall at 1:00.

The other transducer is mounted on the fan case at 4:30.

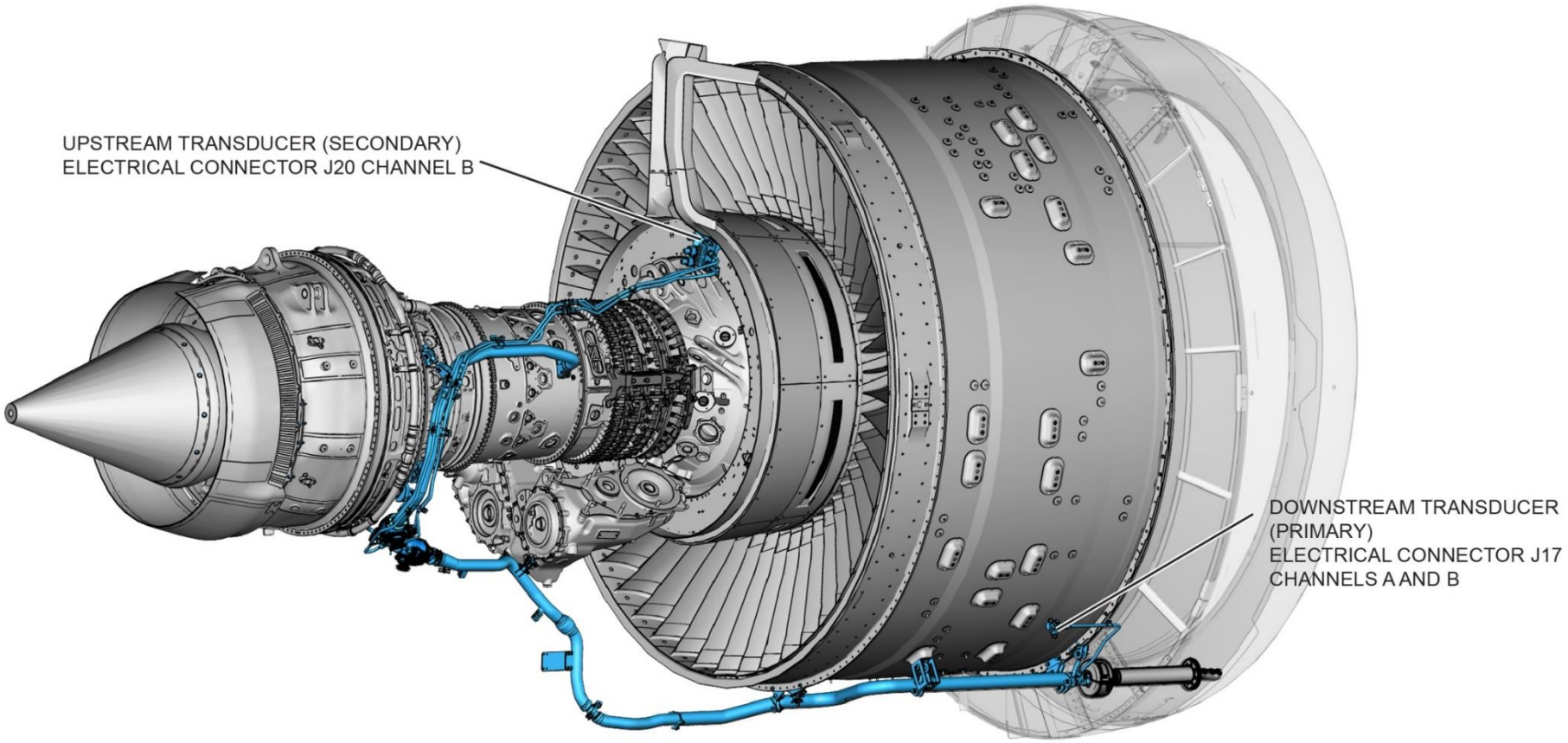
Description:

The downstream pressure transducer is located downstream of the two PRSOVs.

As the primary transducer, its role is to monitor PRSOV positions. It is a dual-channel transducer and provides a pressure signal to Channel A of the EEC.

The upstream pressure transducer is located between the two PRSOVs. Its secondary role is to figure out which PRSOV has failed.

It is a single-channel transducer and provides a pressure signal to Channel B of the EEC.


UPSTREAM TRANSDUCER (SECONDARY)
ELECTRICAL CONNECTOR J20 CHANNEL B
DOWNSTREAM TRANSDUCER
(PRIMARY)
ELECTRICAL CONNECTOR J17
CHANNELS A AND B

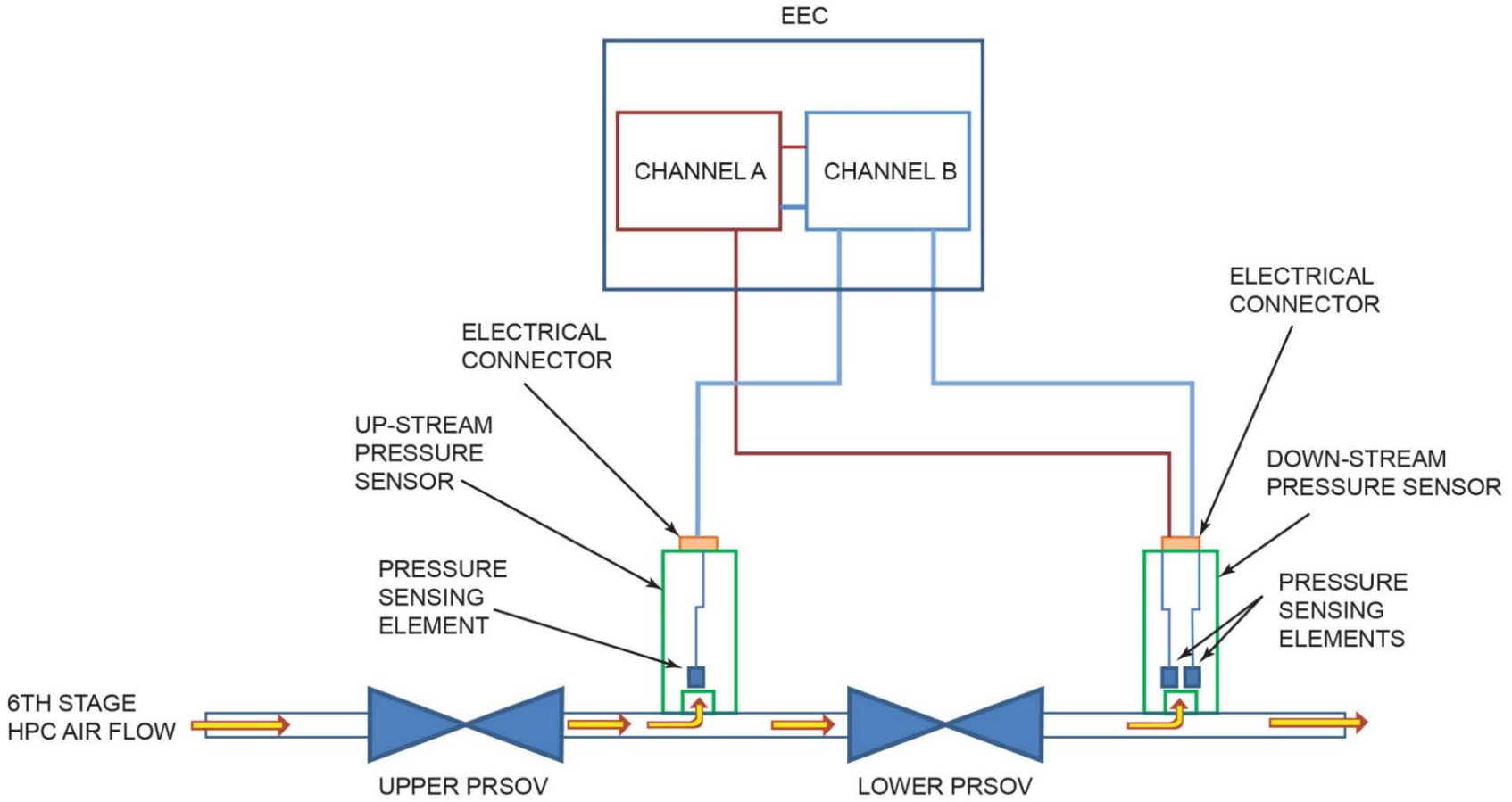
Nacelle Anti Ice (NAI) Pressure Transducers (Cont.)

Operation:

The EEC uses the average of the two pressure signals from the downstream pressure transducer when both signals are valid.

Each EEC channel can use the other channel’s pressure signal in case of single-signal failure.

If both signals are invalid, the EEC will use the last “good” value.


EEC
CHANNEL A
CHANNEL B
ELECTRICAL CONNECTOR
ELECTRICAL CONNECTOR
UP-STREAM PRESSURE SENSOR
DOWN-STREAM PRESSURE SENSOR
PRESSURE SENSING ELEMENT
PRESSURE SENSING ELEMENTS
6TH STAGE HPC AIR FLOW
UPPER PRSOV
LOWER PRSOV

Fan Compartment Thermocouples

Purpose:

Fan compartment thermocouples detect hot air leakage of the NAI System in the fan compartment.

Location:

The two thermocouples are located in the fan case and mounted to a connection plate at 5:00.

Description:

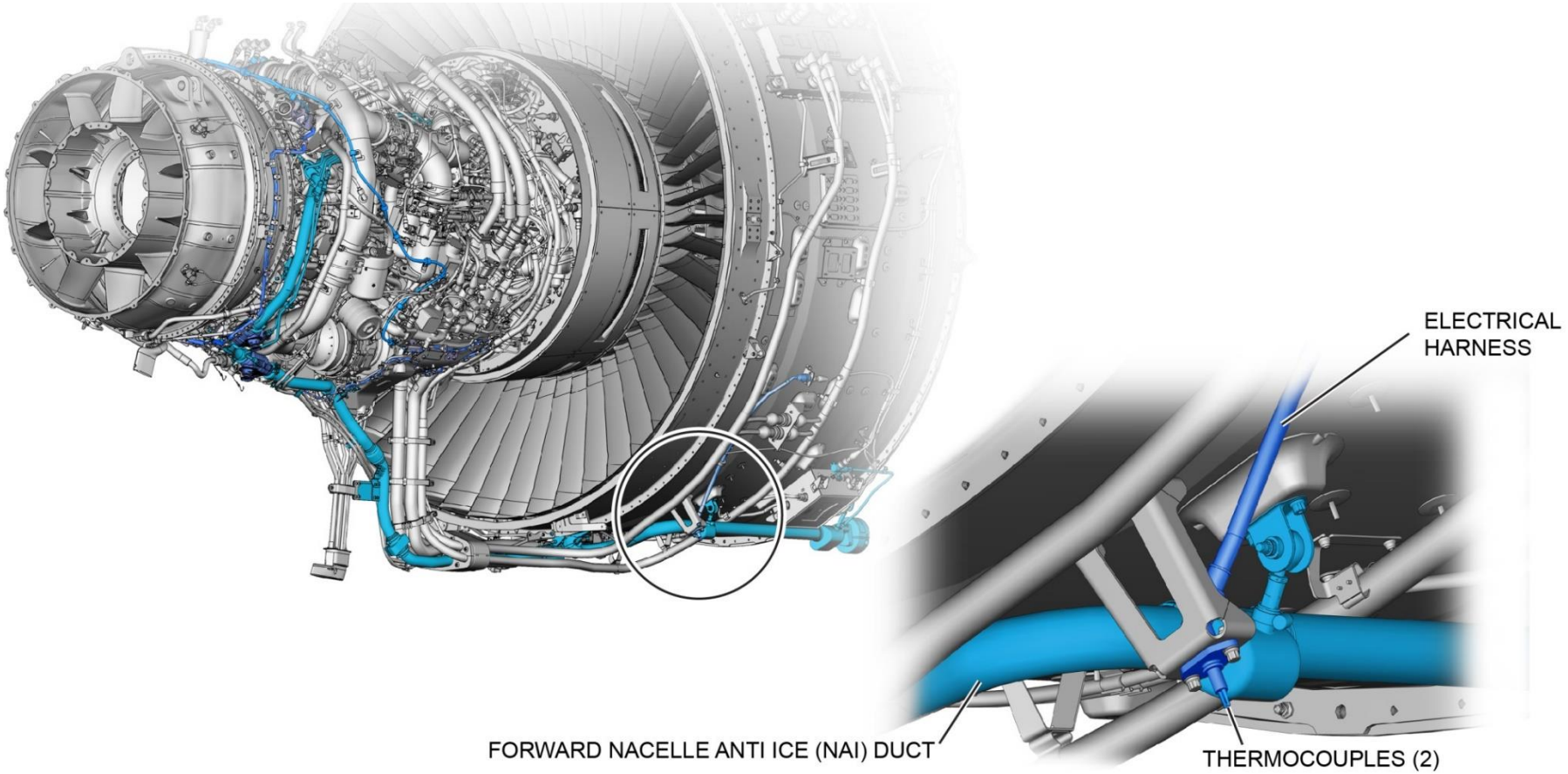
The two Type K thermocouples, one for each EEC channel, are mounted in series with two RTDs that are used as Cold Junction Compensation (CJC).

The thermocouples provide the EEC with temperature measurement in the fan compartment.

Operation:

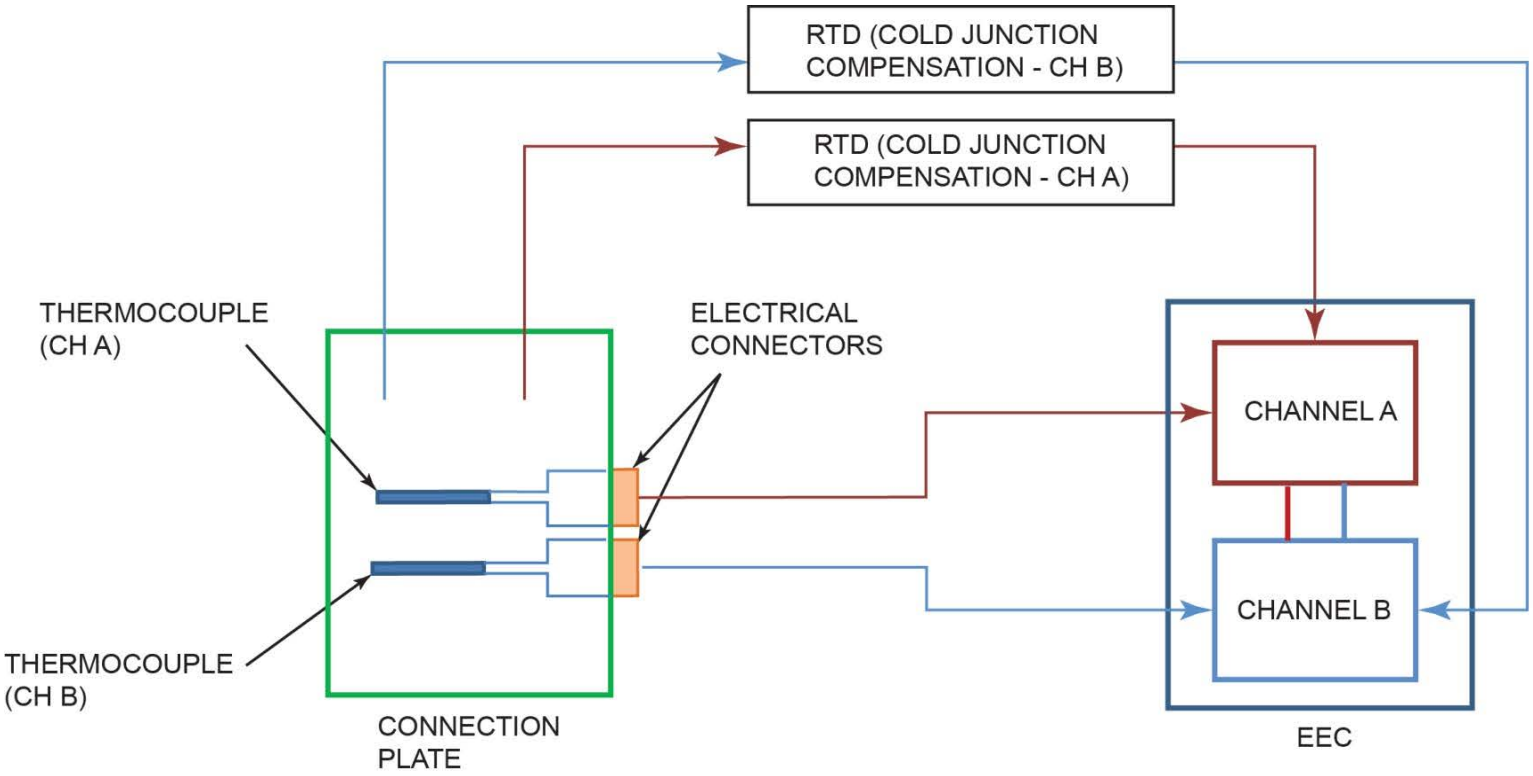
The EEC uses the average of the two temperature signals when both signals are valid. Each EEC channel can use the other channel's thermocouple signal or RTD signal in case of single signal failure.

If both signals are invalid, the EEC is unable to detect a hot air leakage event.


ELECTRICAL HARNESS
FORWARD NACELLE ANTI ICE (NAI) DUCT
THERMOCOUPLES (2)

Operation (Cont.):

When the temperature in the fan compartment exceeds a given value on either EEC channel, each channel will detect a hot air leakage event. Once the event has been detected, the EEC powers both solenoids to close the two PRSOVs.


RTD (COLD JUNCTION COMPENSATION - CH B)
RTD (COLD JUNCTION COMPENSATION - CH A)
THERMOCOUPLE (CH A)
ELECTRICAL CONNECTORS
CHANNEL A
CHANNEL B
THERMOCOUPLE (CH B)
CONNECTION PLATE
EEC

Nacelle Anti Ice (NAI) Ducts

Purpose:

The NAI ducts supply hot HPC 6th Stage air to the inlet cowl forward lip to prevent ice build-up.

Location:

The ducts are located on the right side of the engine, leading from the diffuser case at 2:30 rearward, to the low turbine, down to the bifurcation wall at 6:00 and into the rear of the inlet cowl at 5:00.

Description:

Ducting is segmented into four sections that route hot air from the High-Pressure Compressor 6th Stage bleed port to the inlet swirl nozzle interface. See the table for duct diameter measurements.

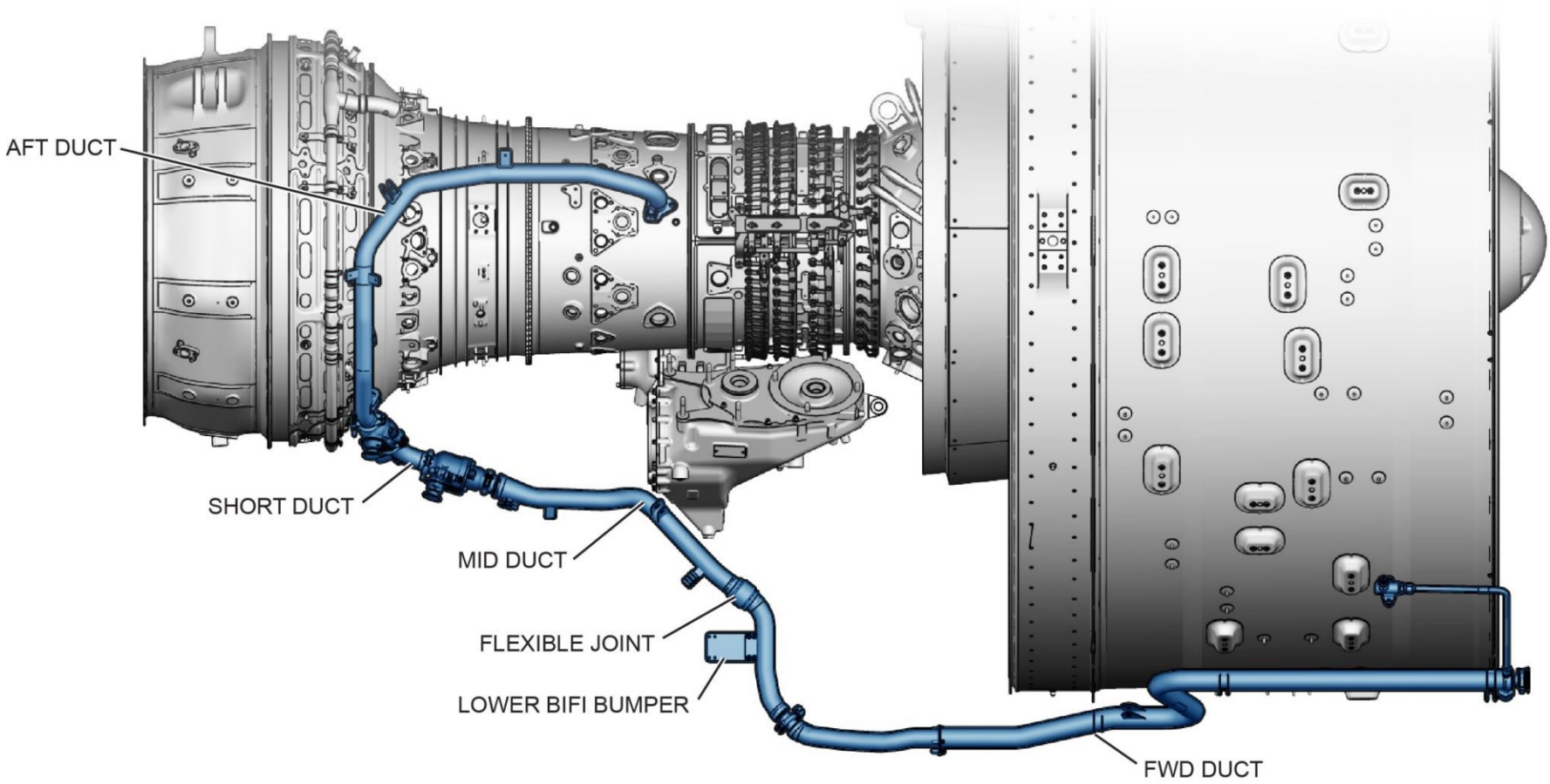
Operation:

The MID and FWD ducts have insulation along the entire length of the duct. The MID duct incorporates a flexible joint that allows for thermal expansion during operation.

In addition, it has a lower Bifurcation (BiFi) bumper that provides lateral restraint thermal expansion of the duct and maintains clearances between BiFi walls.

Ducting is secured throughout the routing by links attached to the engine case and to V-Band clamps.

Duct	Diameter
AFT	1.5 in.
Short	
MID	
FWD	1.5 in. tapering to 1 in.


AFT DUCT
SHORT DUCT
MID DUCT
FLEXIBLE JOINT
LOWER BIFI BUMPER
FWD DUCT

Swirl Nozzle

Purpose:

The swirl nozzle delivers HPC Stage 6 air controlled by the NAI System to prevent ice build-up in the inlet cowl.

Location:

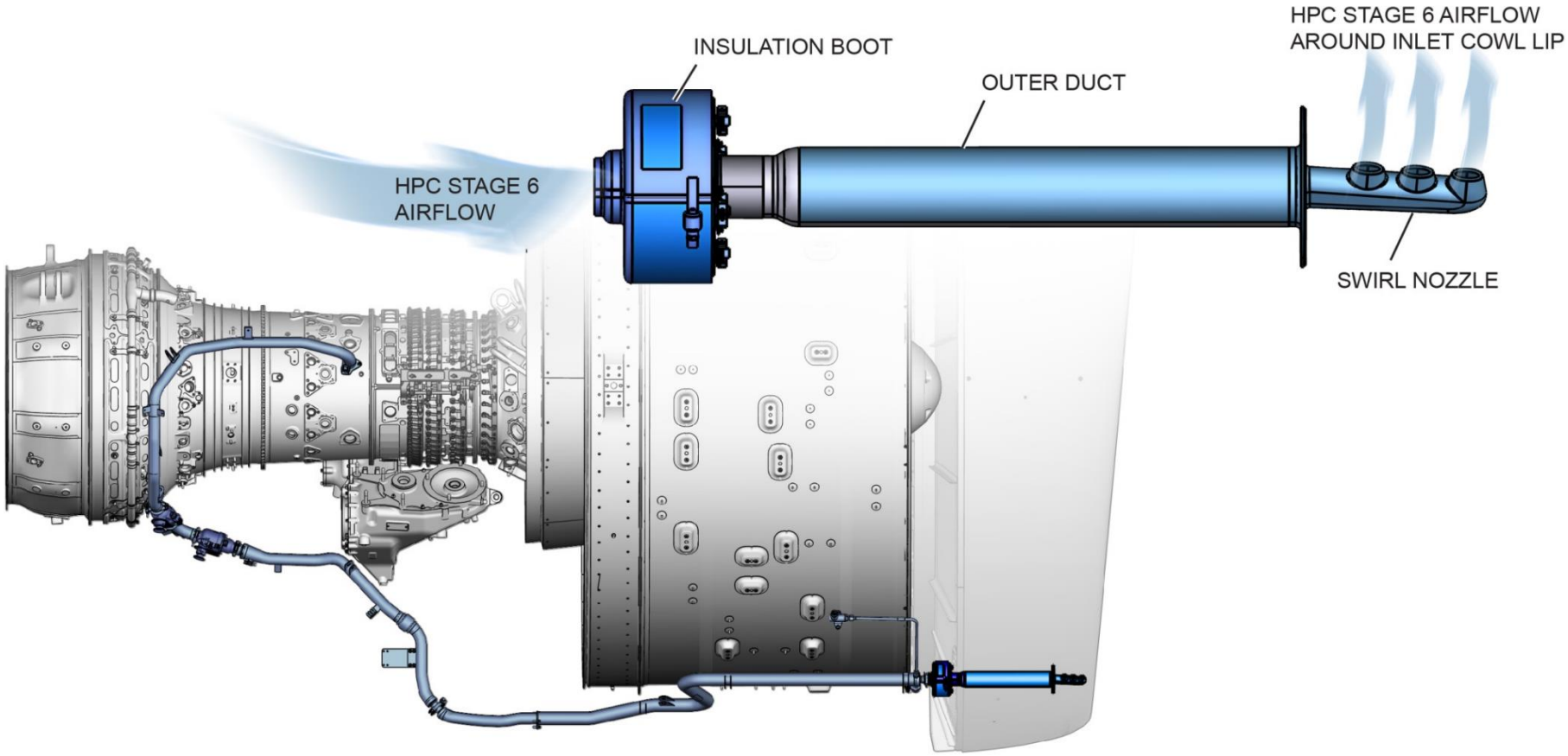
The nozzle is attached to the rear of the inlet cowl at 5:00.

Description:

The swirl nozzle is a dual-walled duct that provides the path for the system to inject a small amount of hot, high-pressure air through a convergent nozzle.

Operation:

The air traveling through the nozzle is sent tangentially into the nose lip of the inlet cowl.

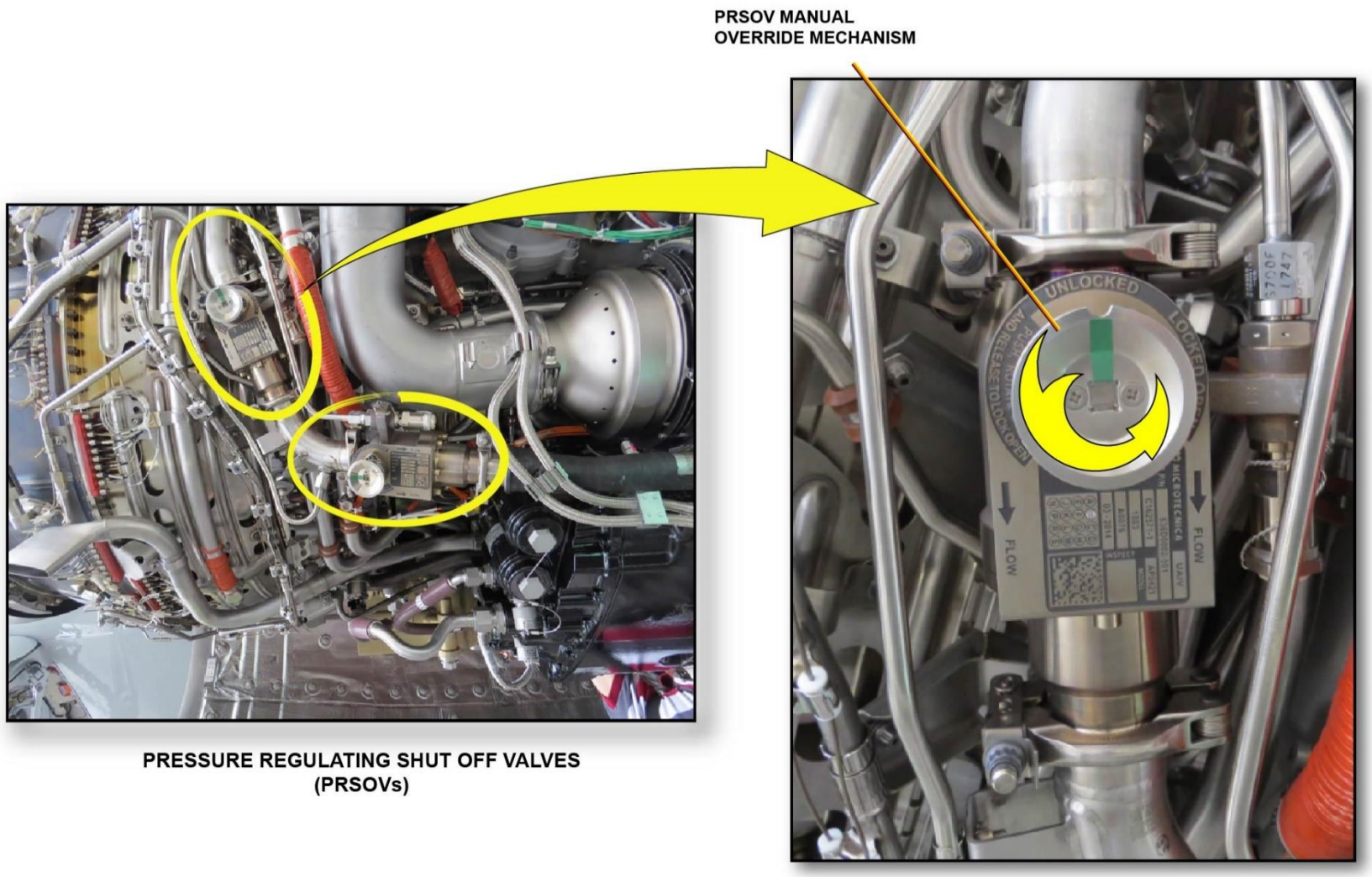

HPC STAGE 6 AIRFLOW
AROUND INLET COWL LIP
INSULATION BOOT
OUTER DUCT
HPC STAGE 6
AIRFLOW
SWIRL NOZZLE

MEL/DEACTIVATION

ENGINE AIR INTAKE ICE PROTECTION - NEO PW

The Engine Air Intake Valve is controlled and monitored by the Engine Electronic Control (EEC).

In case of failure, the Aircraft may be dispatched as per Master Minimum Equipment List (MMEL) with one ENGINE anti-ice valve deactivated in the OPEN position through the Manual Override mechanism on the Pressure Regulating Shut-Off Valve (PRSOV).



PRESSURE REGULATING SHUT OFF VALVES
(PRSOVs)

INTENTIONALLY BLANK