CHAPTER

75

Engine Air

(CFM56 ENGINES (CFM56-7))

CHAPTER 75
ENGINE AIR

A = Added, R = Revised, D = Deleted, O = Overflow, C = Customer Originated Change

CHAPTER 75
ENGINE AIR

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CHAPTER 75
ENGINE AIR

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ENGINE AIR - INTRODUCTION

Purpose

The engine air system has these control functions:

- Turbine clearance
- Compressor airflow.

Turbine Clearance Control

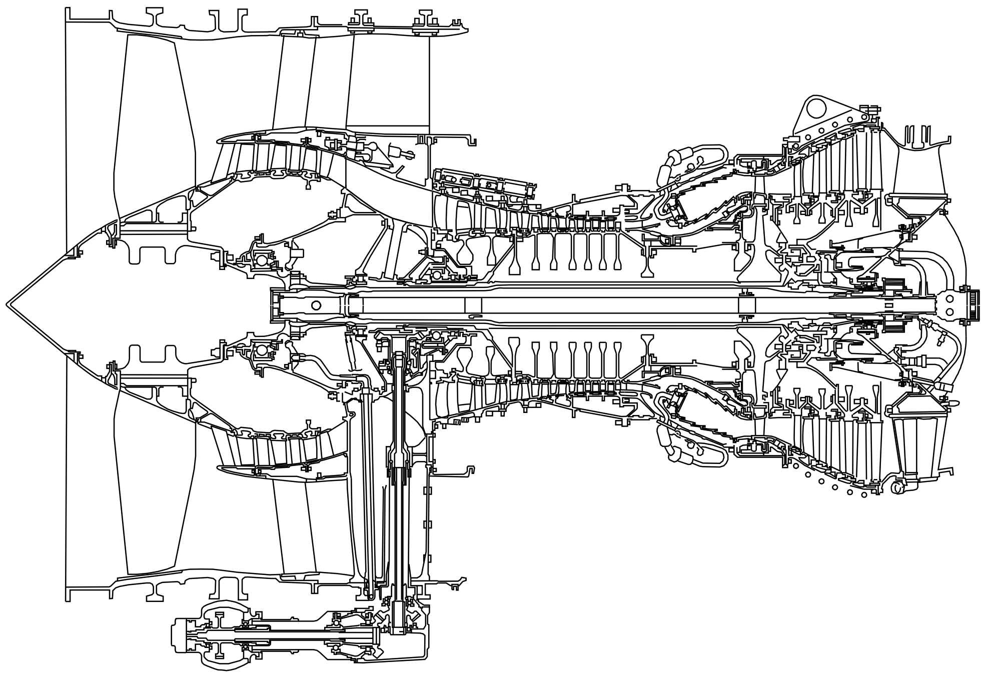
The engine air system adjusts the clearances between the high pressure turbine (HPT) blades and shroud and the low pressure turbine (LPT) blades and shroud. Usually, the engine air system decreases the clearance between the rotors and the turbine case. This helps the engine use less fuel. The engine air system also increases the clearance between the high pressure turbine blades and shroud during some power conditions. This makes sure the HPT blades tips do not rub against the case.

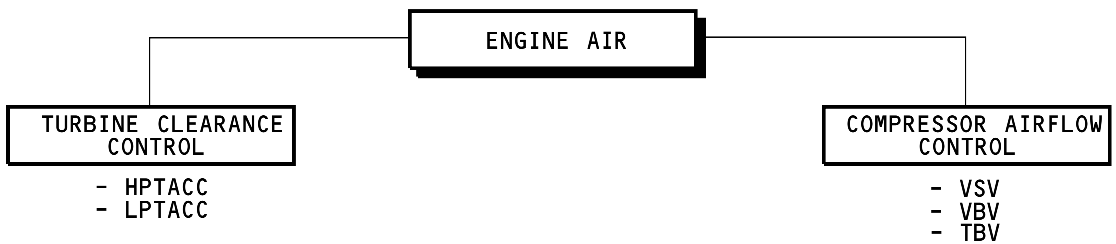
Compressor Airflow Control

The engine air system adjusts the low pressure compressor (LPC) and the high pressure compressor (HPC) air flows for all power conditions. These adjustments prevent an engine stall.

Abbreviations and Acronyms

- ADIRU - air data inertial reference unit
- DEU - display electronic unit
- EEC - electronic engine control
- EGT - exhaust gas temperature
- HMU - hydromechanical unit
- HPC - high pressure compressor
- HPT - high pressure turbine
- HPTACC - high pressure turbine active clearance control
- LPC - low pressure compressor
- LPT - low pressure turbine
- LPTACC - low pressure turbine active clearance control
- LVDT - linear variable differential transformer
- P0 - aircraft static air pressure
- PT - aircraft total air pressure
- RVDT - rotary variable differential transformer
- TAT - aircraft total air temperature
- TBV - transient bleed valve
- TRA - thrust lever resolver angle
- T3 - compressor discharge air temperature
- T25 - HPC inlet air temperature
- VBV - variable bleed valve
- VSV - variable stator vanes
- TCC - turbine case support temperature





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ENGINE AIR - INTRODUCTION

ENGINE AIR - GENERAL DESCRIPTION

General

The electronic engine control (EEC) receives airplane system data from the display electronic units (DEUs). The EEC uses this data to control the engine air system. The EEC changes the bleed airflows to change the turbine blade tips clearances. The EEC also controls compressor airflows to prevent stall. The EEC operates the air valves and the actuators through the hydromechanical unit (HMU). HMU servo fuel pressure moves the valves and the actuators.

The engine air system has these subsystems:

- Turbine clearance control
- Compressor airflow control.

See the engine and fuel control chapter for more information on the EEC. (CHAPTER 73)

Turbine Clearance Control

The engine air system controls turbine tip clearance when it controls the amount of cooling air that goes onto the turbine case. Turbine blade tip clearances decrease when the turbine case is cooled.

These are the turbine clearance control sub-systems:

- High pressure turbine active clearance control (HPTACC)
- Low pressure turbine active clearance control (LPTACC)
- Transient bleed valve (TBV).

The HPTACC system sends HPC 4th-stage and 9th-stage air to the high pressure turbine (HPT) shroud support. The air flows through an HPTACC valve.

The LPTACC system sends fan discharge air to the low pressure turbine (LPT) case. The air flows through the LPTACC valve.

The TBV sends HPC 9th stage air to the low pressure turbine stage 1 nozzles for these two conditions:

- Engine start
- Engine acceleration.

The TBV prevents HPC stall during start and acceleration.

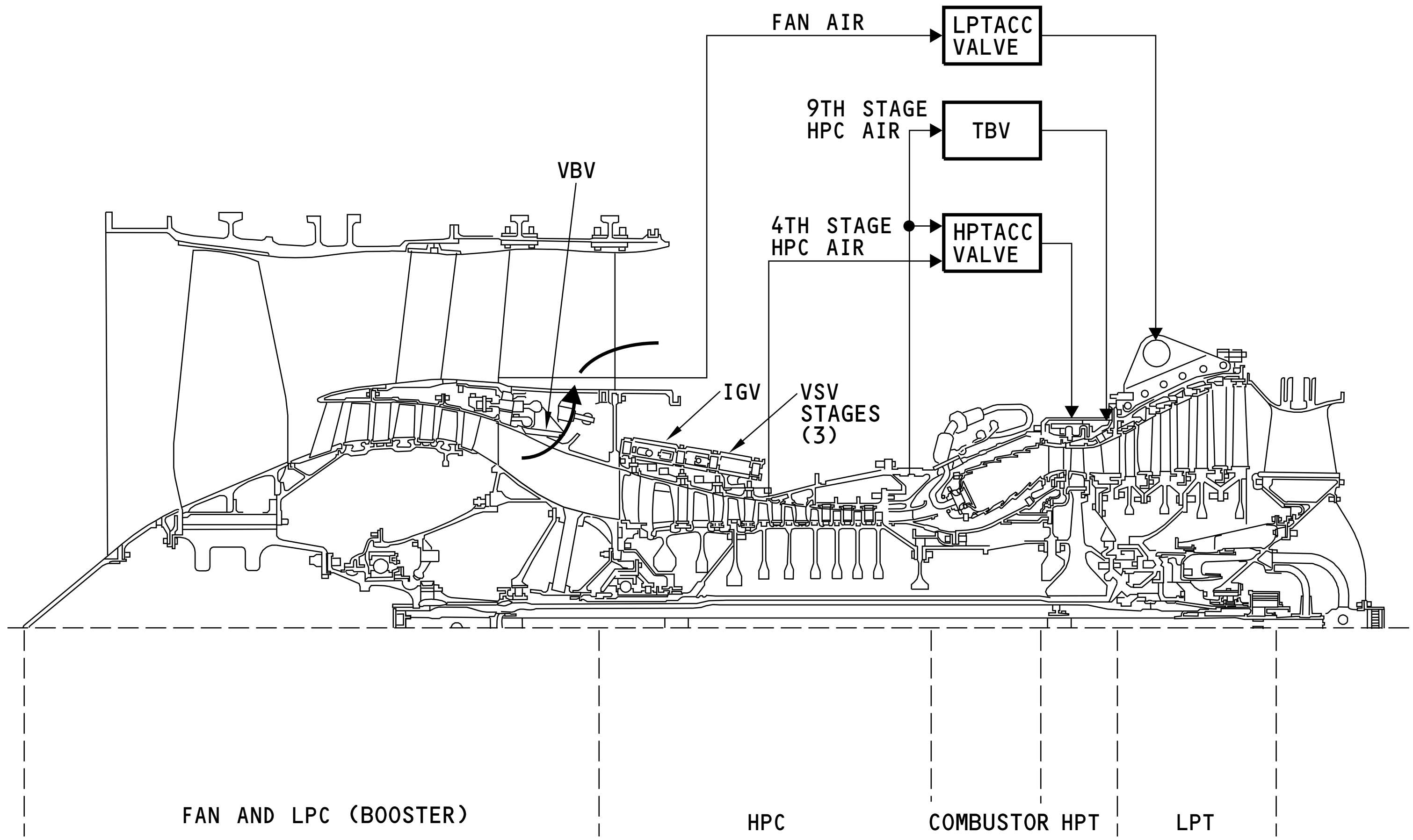
Compressor Airflow Control

These are the compressor airflow control subsystems:

- Variable stator vanes (VSVs)
- Variable bleed valve (VBV).

The VSV system controls the high pressure compressor (HPC) airflow. The VSV system makes sure the correct quantity of air flows through to the HPC which prevents HPC stall. The VSV system controls the HPC inlet guide vanes and the variable stator vanes of the HPC. The first three stages of the HPC have variable stator vanes.

The VBV system controls the low pressure compressor (LPC) discharge airflow. There are 12 variable bleed valves that let some LPC discharge air bypass the engine and mix with the fan discharge air. This airflow prevents LPC stall during fast deceleration. The VBVs also keep water out of the HPC and prevent foreign object damage (FOD) during low speed operation and during reverse thrust operation.



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ENGINE AIR - GENERAL DESCRIPTION

ENGINE AIR - FUNCTIONAL DESCRIPTION

High Pressure Turbine Active Clearance Control (HPTACC)

The EEC calculates commanded high pressure turbine clearance as a function of engine and P0 (altitude) data. P0 is the ambient pressure. P0 data usually comes from the ADIRUs through the display electronic units (DEUs). The HPTACC valve controls the amount of HPC 9th stage and 4th stage air that goes to the HPT shroud support. The EEC sends a command signal to the HMU. The HMU sends servo fuel pressure to move the actuator in the HPTACC valve. Two linear variable differential transducers (LVDTs) send the actuator position data to the EEC for closed-loop control.

See the engine fuel and control section for more information on how the EEC gets P0 pressure. (SECTION 73-21)

Low Pressure Turbine Active Clearance Control (LPTACC)

The EEC calculates the commanded low pressure turbine blade tip clearance as a function of engine and airplane data. The airplane data usually comes from the ADIRUs through the DEUs. The LPTACC valve controls the amount of fan discharge air that goes to the LPT case. The EEC sends a command signal to the HMU. The HMU sends servo fuel pressure to move the actuator in the LPTACC valve. Two rotary variable differential transducers (RVDTs) send the valve position data to the EEC for closed-loop control.

Variable Stator Vanes (VSVs)

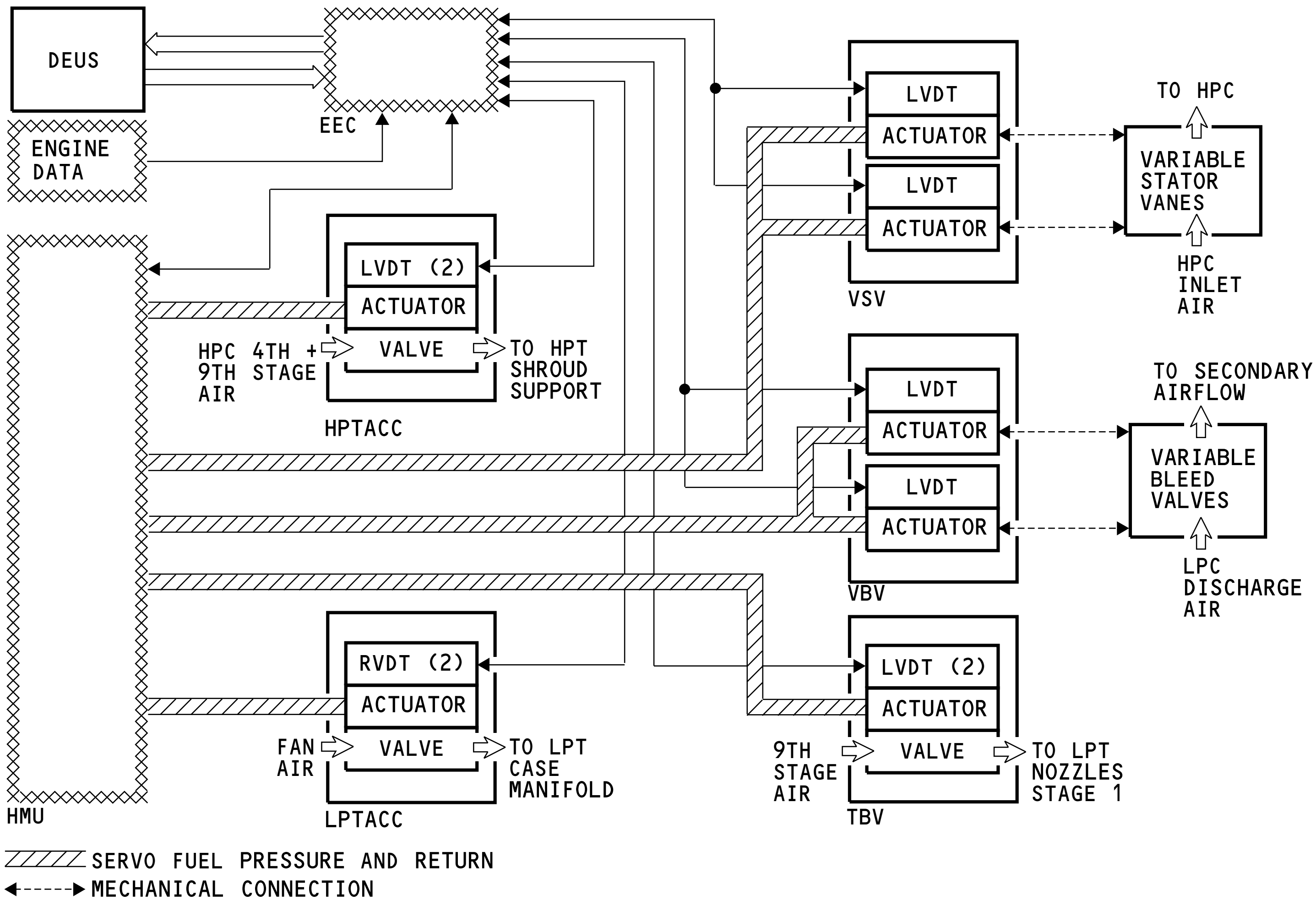
The EEC calculates the commanded VSV position as a function of the engine and airplane data. The airplane data usually comes from the ADIRUs through the DEUs. The EEC controls the two VSV actuators to modulate the amount of air that goes through the HPC. The EEC sends a command signal to the HMU. The HMU sends servo fuel pressure to move the two actuators. The actuators mechanically connect with the stator vanes. Two LVDTs send the position data of the actuators to the EEC for closed-loop control.

Variable Bleed Valve (VBV)

The EEC calculates the commanded VBV position as a function of engine speed and airplane data. The airplane data usually comes from the ADIRUs through the DEUs. The VBVs control the amount of LPC discharge air that goes into the fan discharge airflow. The EEC sends a command signal to the HMU. The HMU sends servo fuel pressure to move the two actuators. The actuators mechanically connect with the bleed valves. Two LVDTs send the position of the actuators to the EEC for closed-loop control.

Transient Bleed Valve (TBV)

The EEC calculates the commanded TBV position as a function of N2 and if the engine is in start or acceleration. The TBV discharges HPC 9th stage air to the LPT stage 1 nozzles. The EEC sends a command signal to the HMU. The HMU sends servo fuel pressure to move the actuator. Two LVDTs send the valve position data to the EEC for closed-loop control.



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ENGINE AIR - FUNCTIONAL DESCRIPTION

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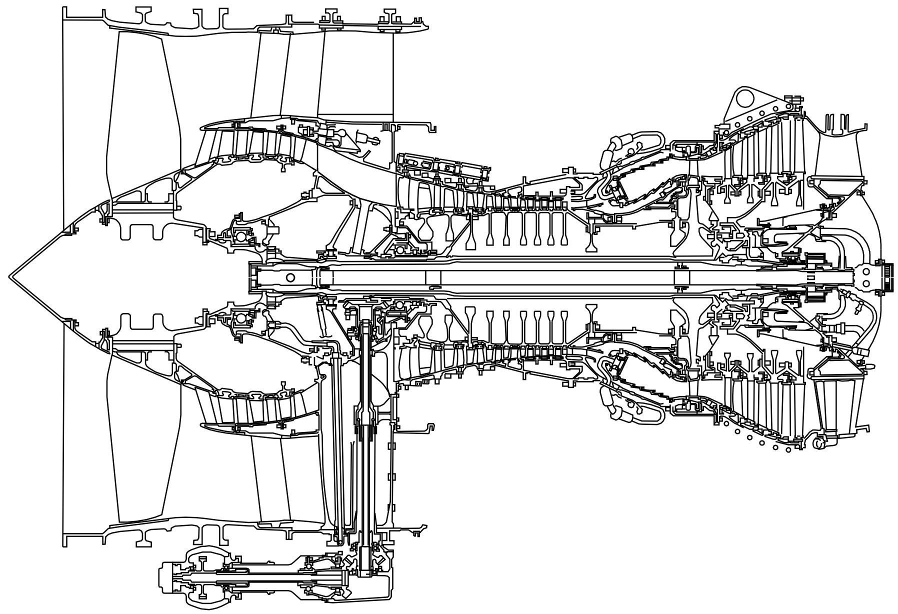
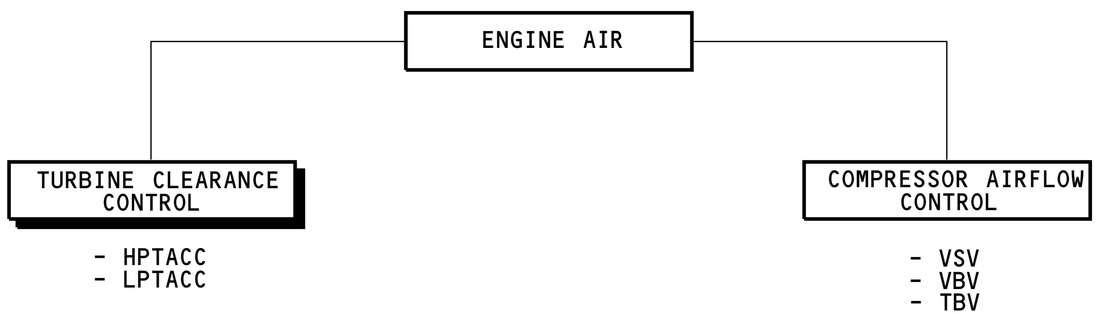
ENGINE AIR - TURBINE CLEARANCE CONTROL - INTRODUCTION

Purpose

The turbine clearance control system has these subsystems:

- High pressure turbine active clearance control(HPTACC)
- Low pressure turbine active clearance control(LPTACC).





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ENGINE AIR - TURBINE CLEARANCE CONTROL - INTRODUCTION

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ENGINE AIR - HIGH PRESSURE TURBINE ACTIVE CLEARANCE CONTROL (HPTACC) - GENERAL DESCRIPTION

General Description

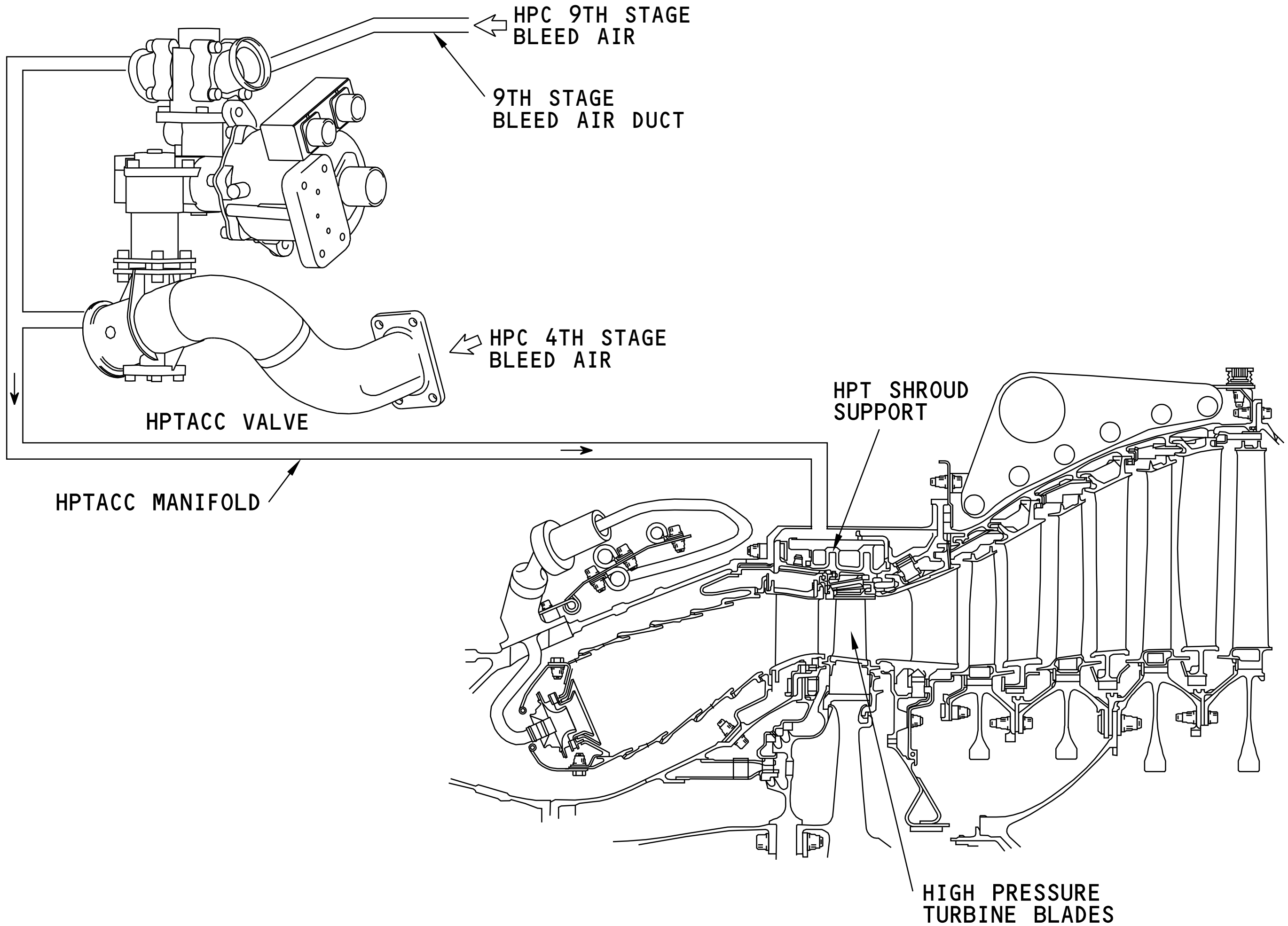
The high pressure turbine active clearance control (HPTACC) system controls air from these two sources:

- HPC 9th stage bleed air
- HPC 4th stage bleed air.

The HPTACC valve mixes the air to control the thermal expansion of the HPT shroud support. Usually, the HPTACC system keeps the clearance between the HPT blade tips and the HPT shroud support to a minimum. This increases the fuel efficiency. But when the engine internal temperature is not stable, or at high power conditions, the HPTACC system increases the turbine clearance. The HPTACC system increases the clearance to make sure that the HPT blades do not touch the shrouds.

The HPTCC system has these parts:

- HPTACC valve (includes the 4th stage bleed air duct)
- 9th stage bleed air duct
- HPTACC manifold.



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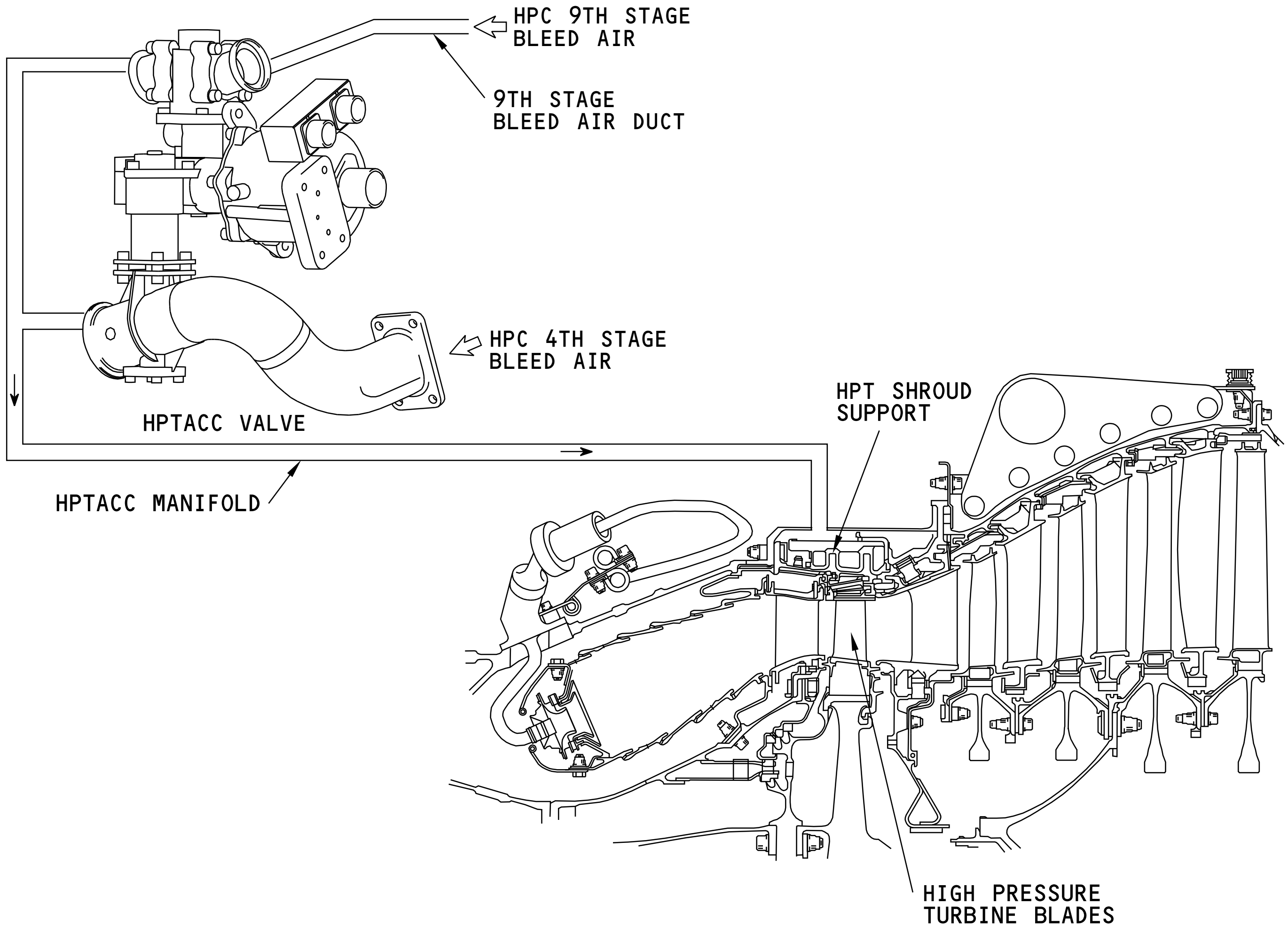
ENGINE AIR - HIGH PRESSURE TURBINE ACTIVE CLEARANCE CONTROL (HPTACC) - GENERAL DESCRIPTION



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ENGINE AIR - HIGH PRESSURE TURBINE ACTIVE CLEARANCE CONTROL (HPTACC) - GENERAL DESCRIPTION

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ENGINE AIR - HPTACC - COMPONENT LOCATION

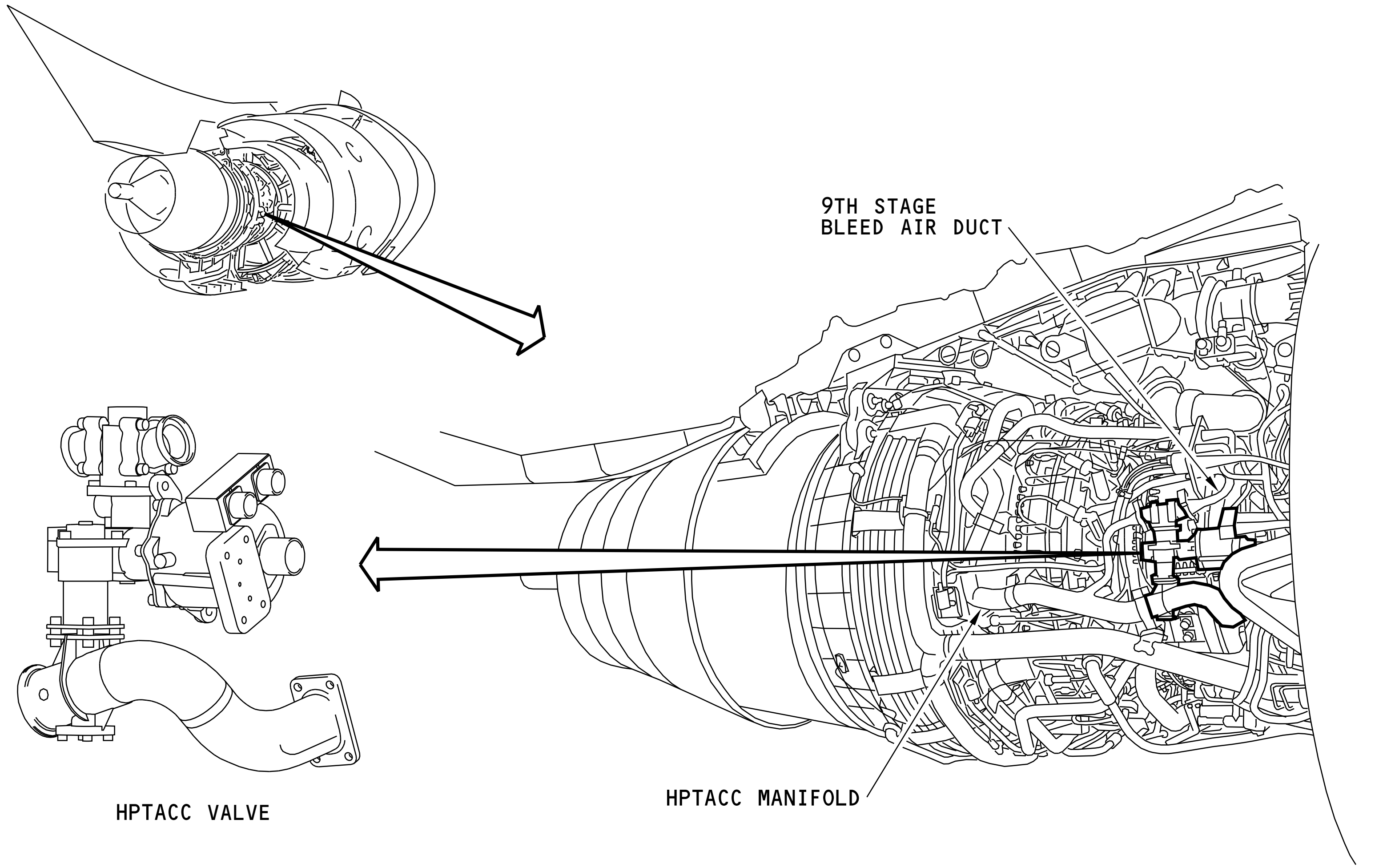
Component Locations

The HPTACC system components are on the right side of the engine HPT case. These are the HPTACC system components:

- HPTACC valve (3:00 position)
- 9th stage bleed air duct (2:00 position)
- HPTACC manifold.

The HPTACC manifold starts aft of the HPTACC valve, and goes around the HPT case. The HPTACC manifold connects to the HPT shroud support through ports at the 6:00 position and the 12:00 position.

You open the right fan cowl and thrust reverser to get access to the HPTACC system components.



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ENGINE AIR - HPTACC - COMPONENT LOCATION

ENGINE AIR - HPTACC - VALVE

Purpose

The HPTACC valve controls the quantity and the ratio of HPC 9th stage and 4th stage bleed air that goes to the HPT shroud support. The HPTACC manifold sends the air mixture to the HPT shroud support.

Physical Description

The HPTACC valve has a 4th stage valve and a 9th stage valve with one actuator that moves both valves. The actuator is a piston type actuator. The HMU sends servo fuel to either the head or rod side of the piston. A shaft with gear teeth on both sides connect to the piston. The teeth on the shaft connect to a gear for the 9th stage valve on one side and to a gear for the 4th stage valve on the other side. The butterfly shaft for each valve connects to the correct gear. When the piston moves, the shaft also moves. This causes the gears and butterfly valves for each valve to turn which causes the valves to open and close. These are the components of HPTACC valve that you can see from the outside of the valve:

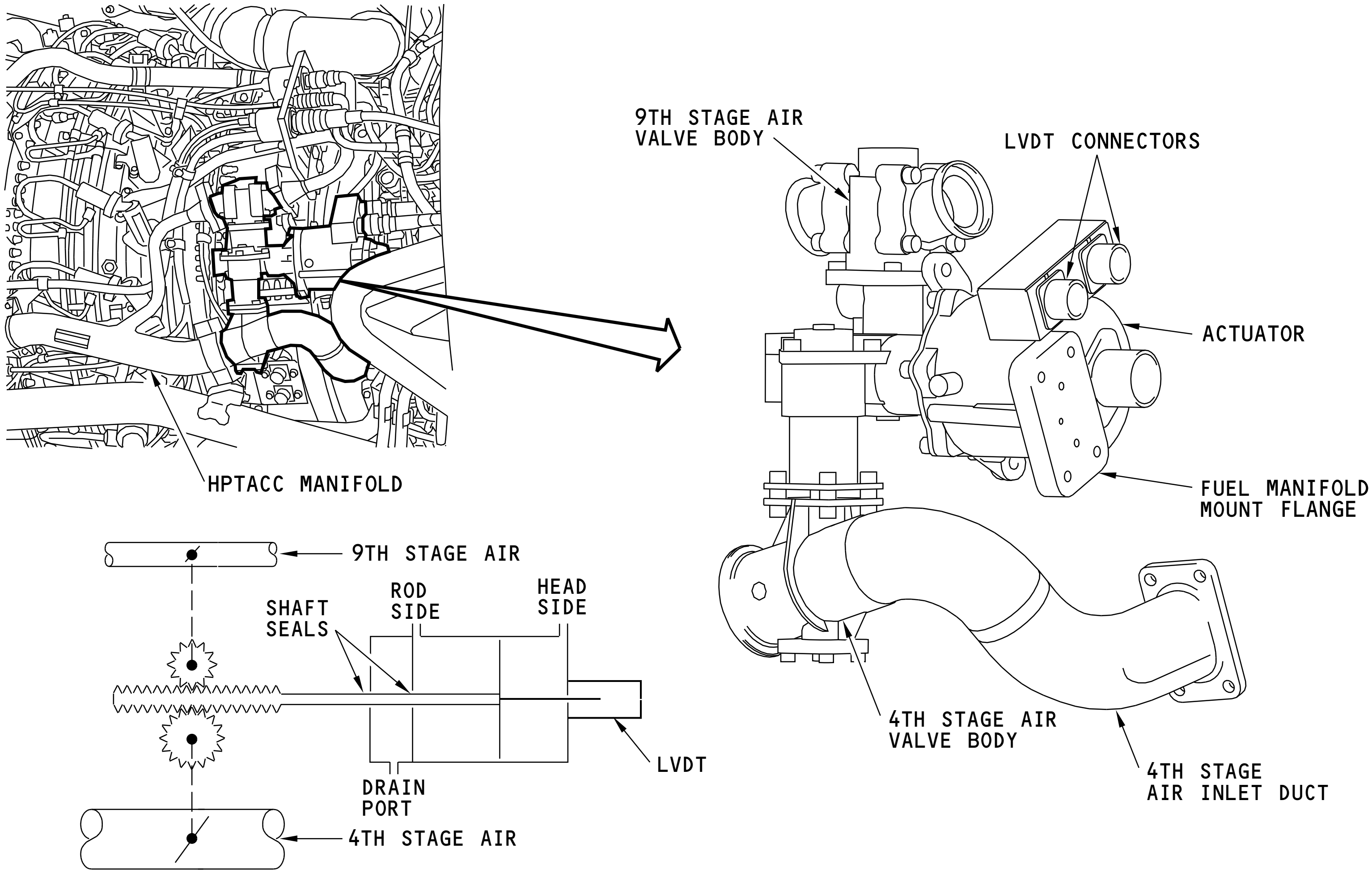
- 9th stage air valve body
- 4th stage air valve body
- One actuator for both valves
- Two LVDT connectors
- Fuel manifold mount flange
- 4th stage air inlet duct.

There are two LVDTs in the HPTACC valve. The LVDTs give the HPTACC valve position signals to the EEC. One LVDT gives valve position to channel A and the other gives valve position to channel B.

Training Information Point

You remove the HPTACC valve as an assembly.

The HPTACC has a drain port to drain fuel that leaks from the shaft seal. See engine vents and drains - inspection/check of the AMM, part II, 71-71 for the allowable leakage rate.



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ENGINE AIR - HPTACC - VALVE

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ENGINE AIR - HPTACC - FUNCTIONAL DESCRIPTION

General

The EEC uses these data to control the HPTACC valve:

- Ambient pressure (P0)
- N2
- Compressor discharge air temperature (T3)
- HPT shroud support temperature (TCC sensor).

The EEC usually receives P0 from the ADIRUs through the display electronic units (DEUs). The other data comes from engine sensors.

See the engine fuel and control section for more information on how the EEC gets P0 pressure. (SECTION 73-21)

Control

The HPTACC system operates automatically. The EEC uses aircraft and engine data to control HPC 9th stage/4th stage bleed air ratio used to cool the HPT shroud support. The EEC uses the P0 sensors in the EEC if the ADIRU data becomes invalid. The EEC sends a HPTACC command signal to the HMU. The HMU sends the correct servo fuel pressure to the rod and head sides of the HPTACC valve. This moves the valves in the HPTACC valve. The valve controls the flow of HPC 9th stage and 4th stage air. This controls the temperature of the air that goes to the HPT shroud support.

The EEC calculates the demand HPT case support temperature (TCC) from N2 speed T3 and altitude (P0). If TCC is too high the EEC sends a signal to the HMU to cool the HPT shroud support. If TCC is too low the EEC sends a signal to the HMU to cool the shroud support less.

The actuator has two LVDTs. The EEC uses the LVDTs to monitor the position of the HPTACC actuator. One LVDT sends an electrical signal to channel A of the EEC. The other LVDT sends an electrical signal to channel B.

Modes of Operation

These are the five HPTACC modes:

- No air - The actuator fully retracts. The HPC 4th stage and the 9th stage valves are closed. This is the actuator position when the engine is off. This is the fail-safe position. The EEC commands the HPTACC valve to this position if there is a malfunction of the EEC or the HMU. The HPT blade tip clearance is maximum when the HPTACC is in this position.
- Low flow 9th stage - The EEC sets the actuator to 8 percent of extension. The 9th stage valve lets a low flow of 9th stage air go to the HPT shroud support. The 4th stage butterfly valve is fully closed. This cools the support shroud a small amount.
- High flow 9th stage - The EEC sets the actuator to 37 percent of extension. The 9th stage valve fully opens. The 4th stage butterfly valve is fully closed. This cools the shroud support more.
- Mixed - The EEC calculates an actuator position between 38 percent and 99 percent. This sets the 9th stage and 4th stage air ratio to accurately adjust the HPT clearance. This cools the shroud support even more.
- Full 4th stage - The actuator fully extends (100 percent). The 9th stage valve is fully closed. The 4th stage valve is fully open. This gives the maximum shroud support cooling which provides the minimum HPT clearance.

The typical HPTACC modes and the airplane condition are listed in this table.

Engine Condition	HPTACC MODEs
Cold Start	Initially full 4th stage, then Transition through mixed mode to full 9th stage
Warm Start	9th stage to minimize HPT rubs.
Take Off and Climb	Initially 4th stage to minimize peak EGT, then transition to mixed mode
Cruise	4th stage to minimize fuel consumption

ENGINE AIR - HPTACC - FUNCTIONAL DESCRIPTION

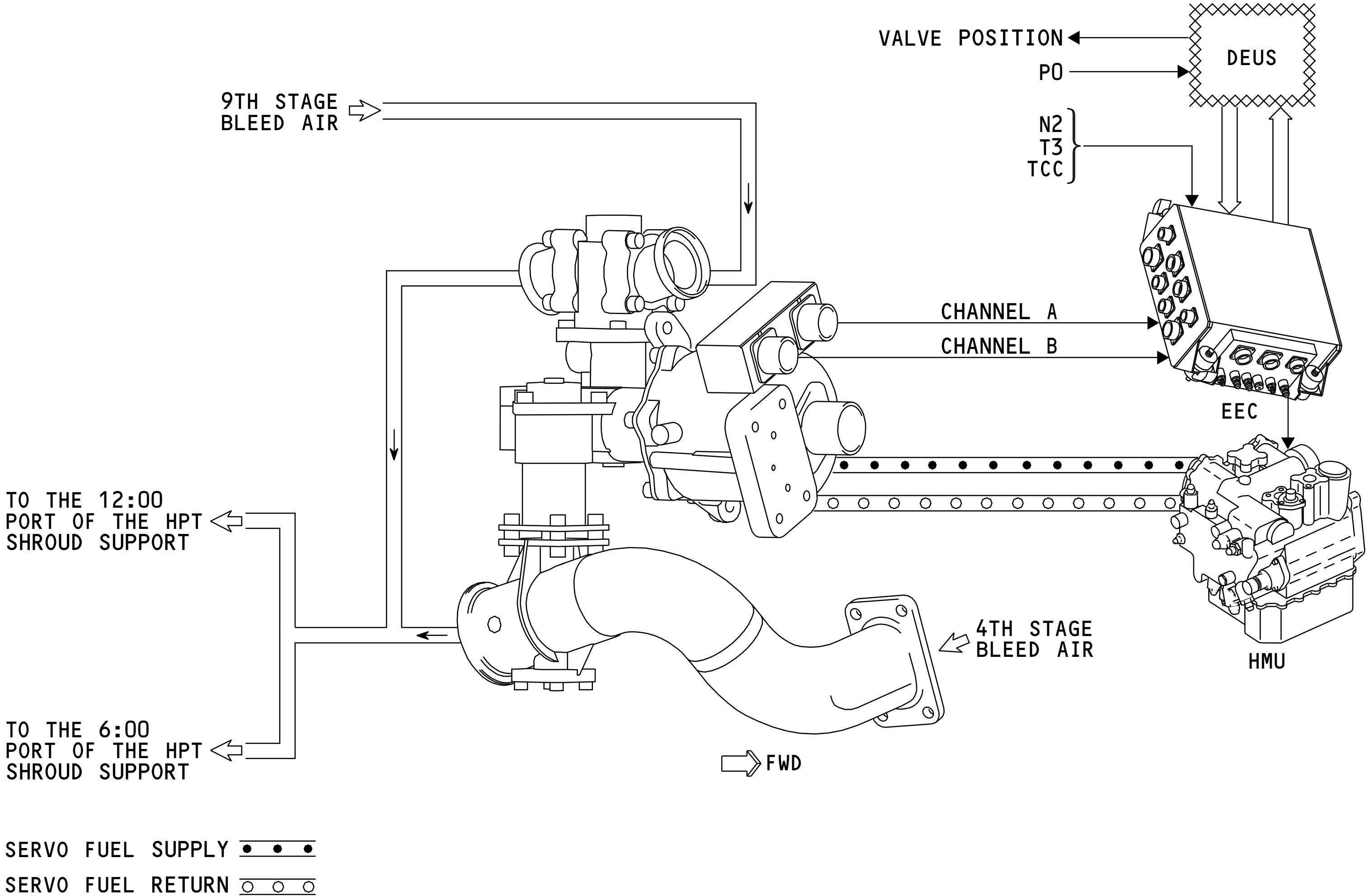
(Continued)

Engine Condition	HPTACC MODEs
Descent	Low flow 9th stage to protect against rubs

Training Information Point

You can see the HPTACC position in percent on the engine maintenance pages of the control display units (CDUs).

See the engine fuel and control section for more information on the engine maintenance pages in the CDU. (SECTION 73-21)



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ENGINE AIR - HPTACC - FUNCTIONAL DESCRIPTION

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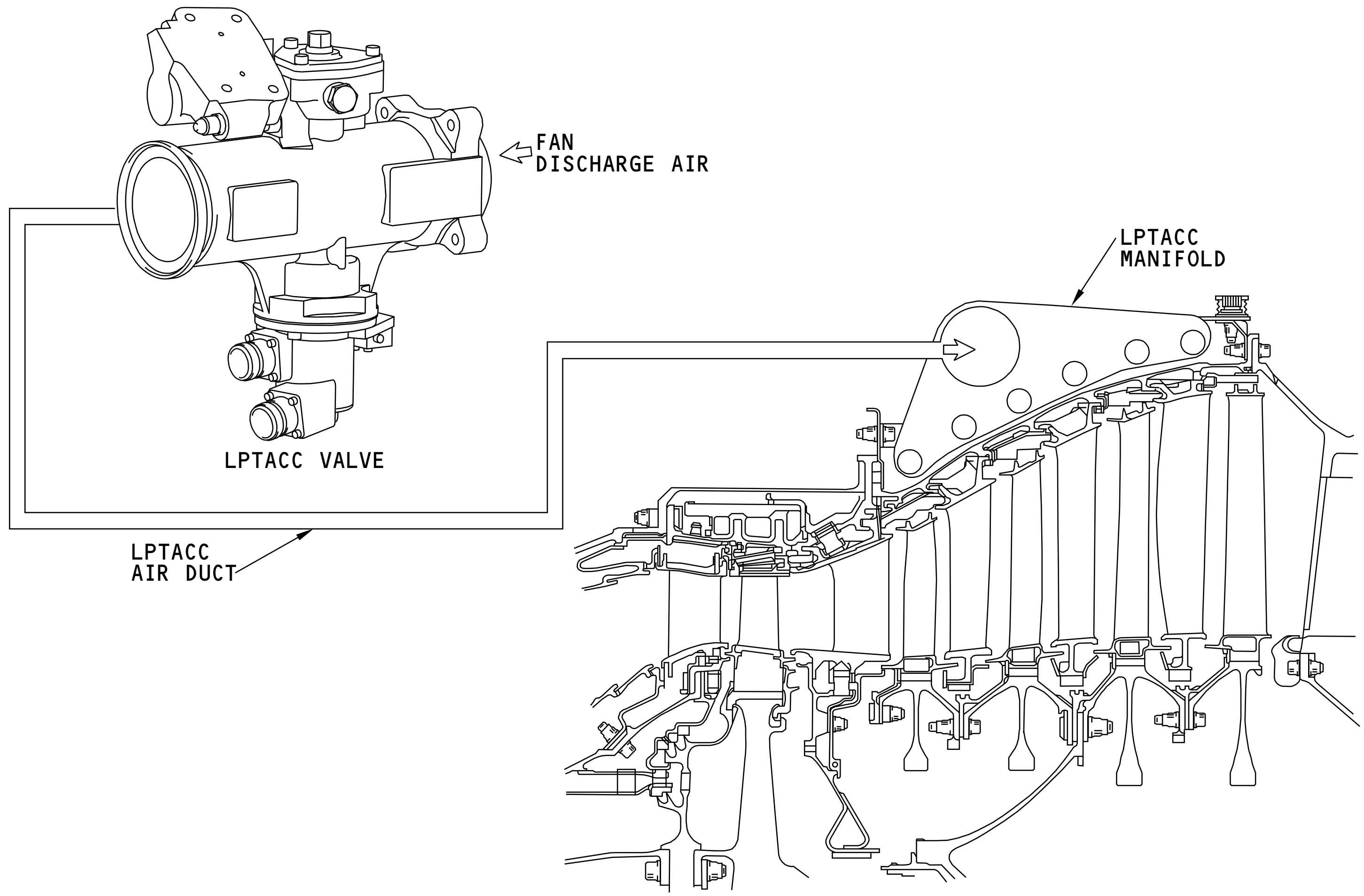
ENGINE AIR - LOW PRESSURE TURBINE ACTIVE CLEARANCE CONTROL (LPTACC) - GENERAL DESCRIPTION

General Description

The low pressure turbine active clearance control (LPTACC) system controls the low pressure turbine (LPT) blade tip clearance. The LPTACC increases or decreases the amount of fan discharge air that goes to the LPT case. This air cools the LPT case. Cooling the LPT case controls thermal expansion which keeps the clearance with the LPT blade tips to a minimum. This increases fuel efficiency.

The LPTACC system has these parts:

- LPTACC valve
- LPTACC air duct
- LPTACC manifold.



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ENGINE AIR - LOW PRESSURE TURBINE ACTIVE CLEARANCE CONTROL (LPTACC) - GENERAL DESCRIPTION

ENGINE AIR - LPTACC - COMPONENT LOCATIONS

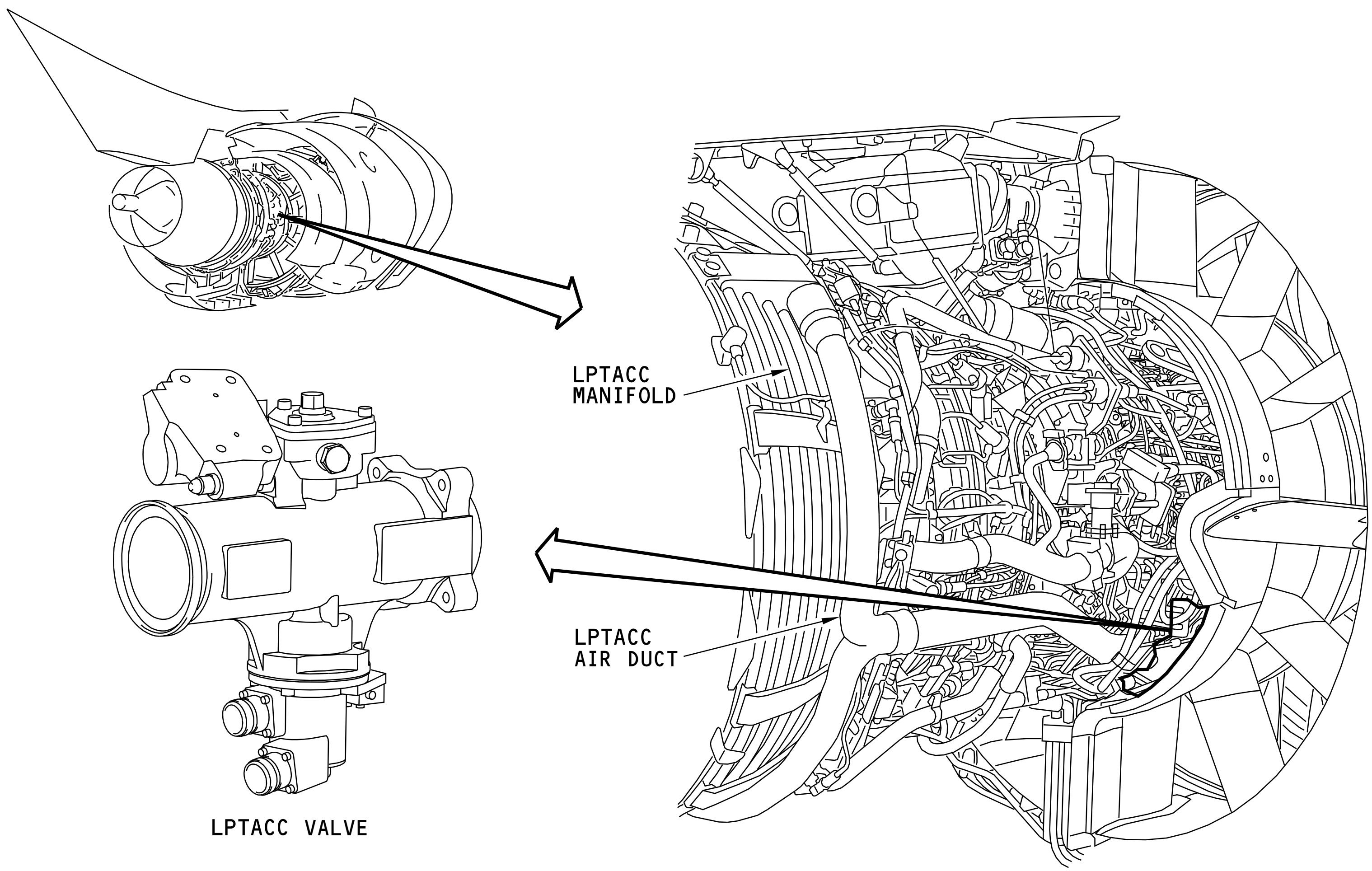
Component Locations

These components of the LPTACC system are on the right side of the engine high pressure compressor (HPC) case:

- LPTACC valve (4:00 position)
- LPTACC air duct (4:00 position).

Air enters the LPTACC intake port in the fan duct. The intake port is at the 4:00 position on the inner wall of the fan duct aft of the fan. the LPTACC valve connects to the intake port. The LPTACC air duct connects the LPTACC valve to the LPTACC manifolds. The LPTACC manifolds surround the low pressure turbine (LPT) case.

You open the right fan cowl and thrust reverser to get access to the LPTACC system components.



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ENGINE AIR - LPTACC - COMPONENT LOCATIONS

ENGINE AIR - LPTACC - VALVE

Physical Description

The LPTACC valve controls the quantity of fan discharge air that goes to the LPT case. The LPTACC manifold sends the fan air to spray tubes around the LPT case. Holes in the spray tubes direct the fan air onto the LPT case. The LPTACC air duct connects the valve and the manifold.

The LPTACC valve is a modulating valve that operates with fuel pressure. It has these parts:

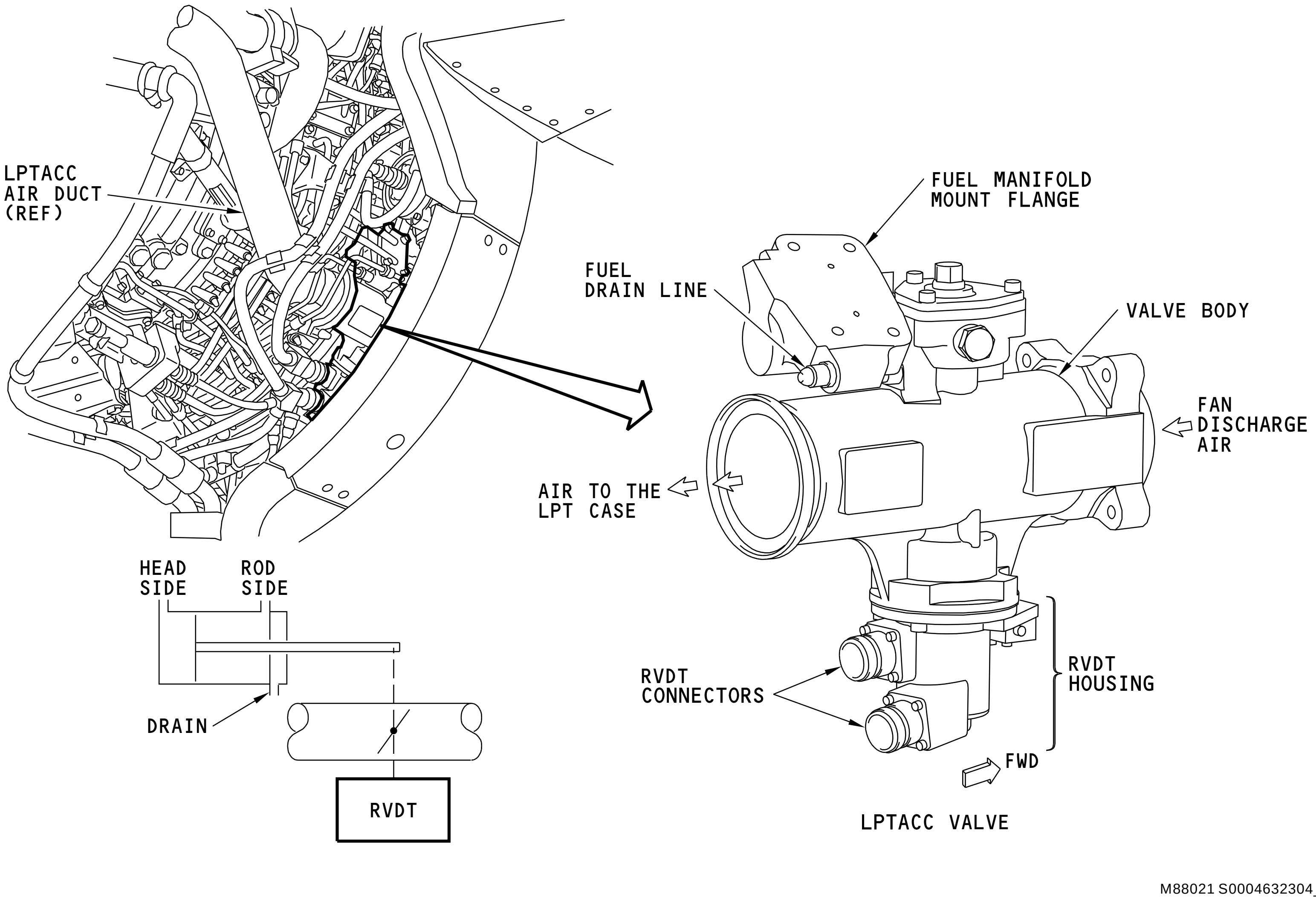
- Valve body
- Rotary variable differential transformer (RVDT) housing
- RVDT connectors (2)
- Fuel manifold mount flange
- Fuel drain line connection
- Actuator
- Butterfly valve.

The actuator and the butterfly valve (not shown) is in the valve body.

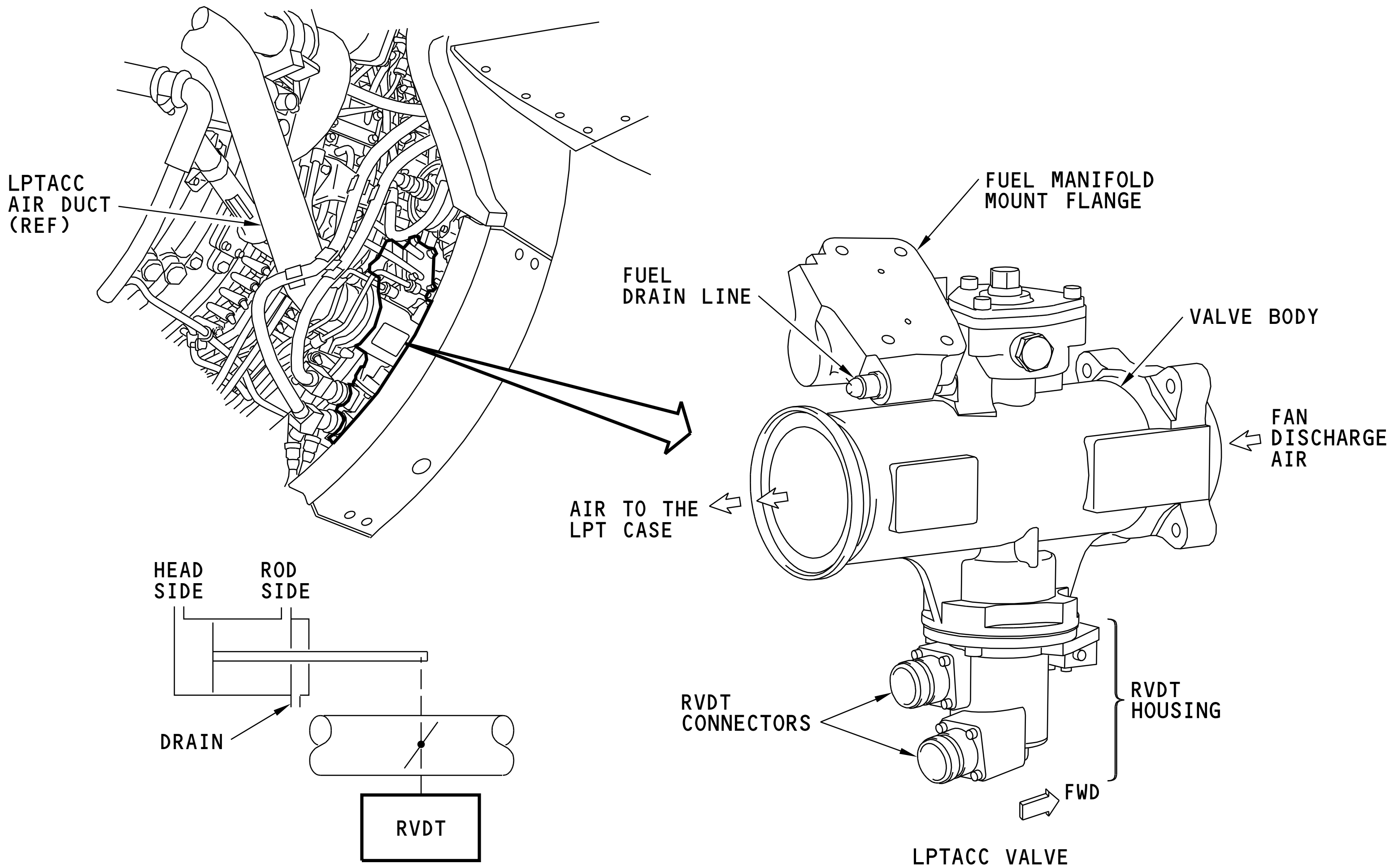
The LPTACC valve has a fuel-operated piston valve. The HMU sends servo fuel to either the rod side or head side of the piston in the actuator. The actuator controls the position of the a butterfly valve. The butterfly valve controls fan air flow to the LPTACC manifold. Two RVDTs send butterfly position signals to the EEC. The LPTACC has a drain port to drain fuel that leaks from the actuator shaft seal.

Training Information Point

You remove the LPTACC valve as an assembly.



ENGINE AIR - LPTACC - VALVE



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ENGINE AIR - LPTACC - VALVE

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ENGINE AIR - LPTACC - FUNCTIONAL DESCRIPTION

General

The EEC uses these data to schedule the LPTACC valve:

- Total air pressure (PT)
- Ambient pressure (P0)
- Total air temperature (TAT)
- N1
- Exhaust gas temperature (EGT).

The EEC calculates the LPT tip clearance based on the airplane and engine data listed above. In general, the LPTACC airflow increases when the parameters above increase.

Control

The LPTACC system operates automatically. The EEC normally gets PO, PT and TAT from the ADIRUs through the display electronic units (DEUs). The EEC gets N1 and EGT from engine sensors. The EEC uses these data to schedule the quantity of fan discharge air that goes to the LPT case. The EEC sends a signal to the HMU. The HMU sends servo fuel pressure to move the piston in the LPTACC valve actuator. The piston connects with the fan discharge air butterfly valve.

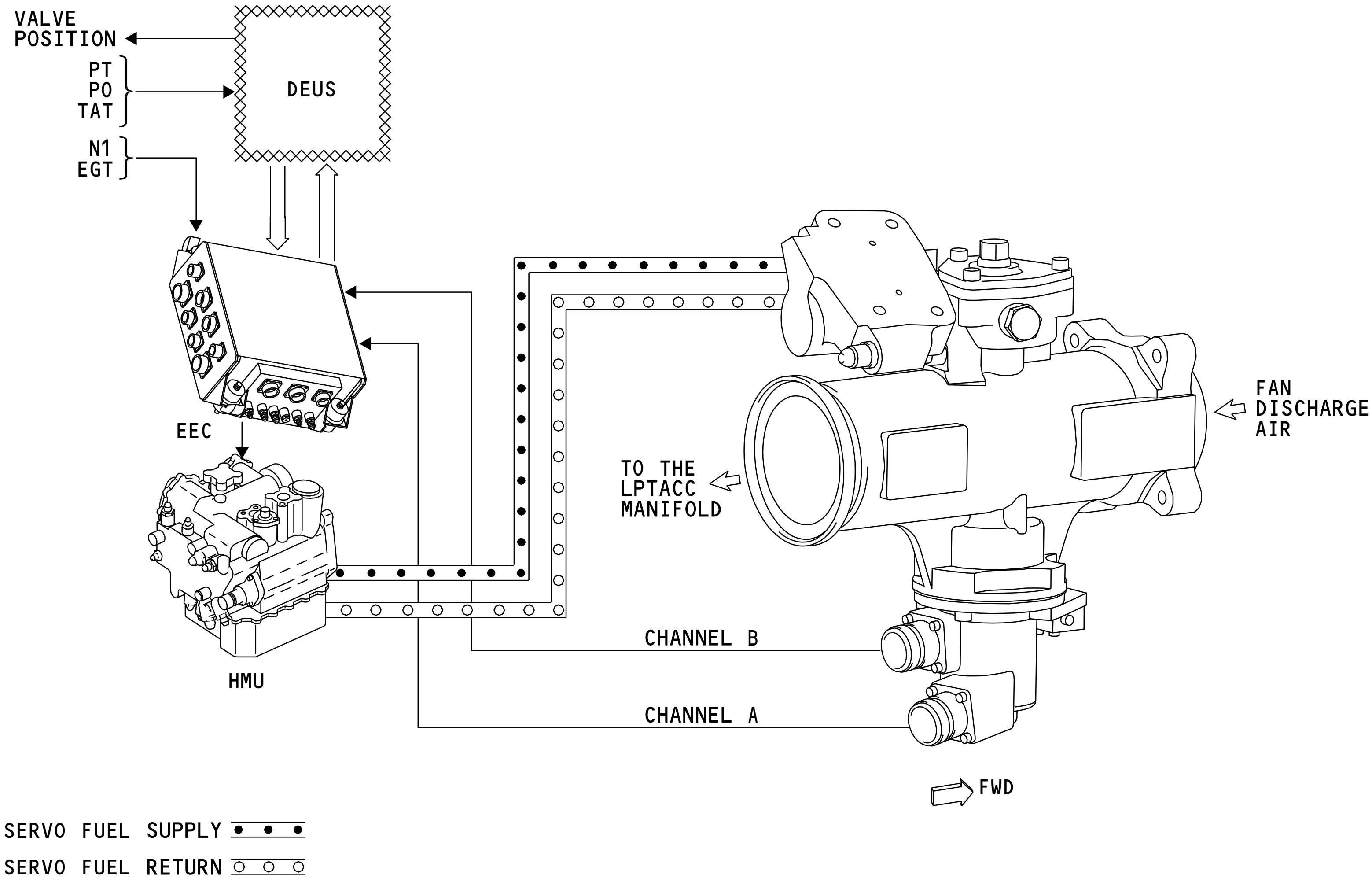
See the engine fuel and control section for more information on how the EEC gets P0, PT and TAT data. (SECTION 73-21)

The LPTACC valve has two RVDTs. The EEC uses the RVDTs to monitor the position of the LPTACC actuator. One RVDT sends the signal to channel A of the EEC. The other RVDT sends the signal to channel B.

Training Information Point

You can see the LPTACC position in percent on the engine maintenance pages of the control display units (CDUs).

See the engine fuel and control section for more information on the engine maintenance pages in the CDU. (SECTION 73-21)



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ENGINE AIR - LPTACC - FUNCTIONAL DESCRIPTION

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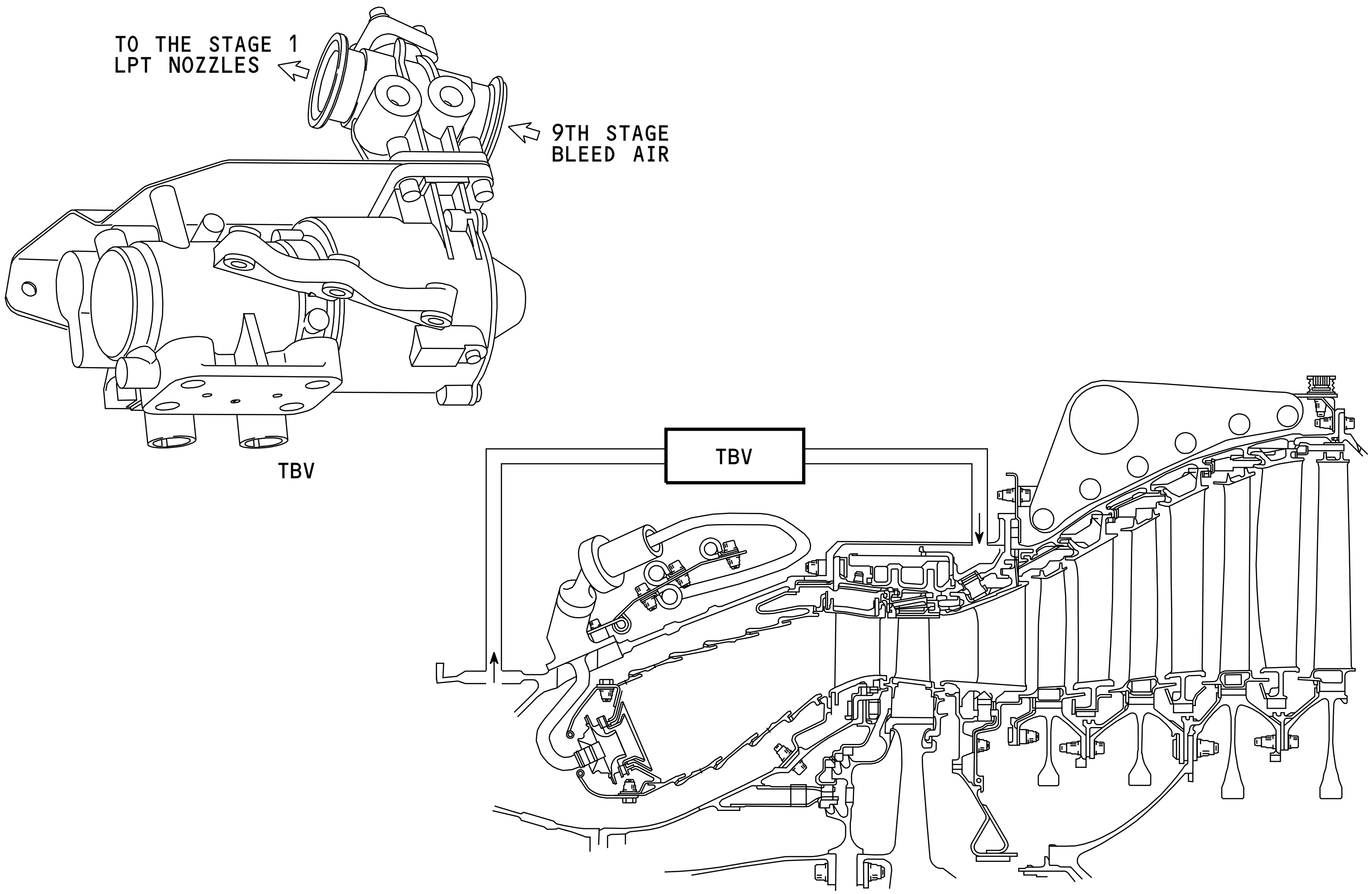
ENGINE AIR - TRANSIENT BLEED VALVE (TBV) - GENERAL DESCRIPTION

General Description

The transient bleed valve (TBV) system controls the quantity of the high pressure compressor (HPC) 9th stage bleed air that goes into the stage 1 low pressure turbine (LPT) nozzles. The TBV system increases the HPC stall margin during engine start and during engine acceleration.

The TBV system has these parts:

- TBV valve
- TBV manifold.



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ENGINE AIR - TRANSIENT BLEED VALVE (TBV) - GENERAL DESCRIPTION

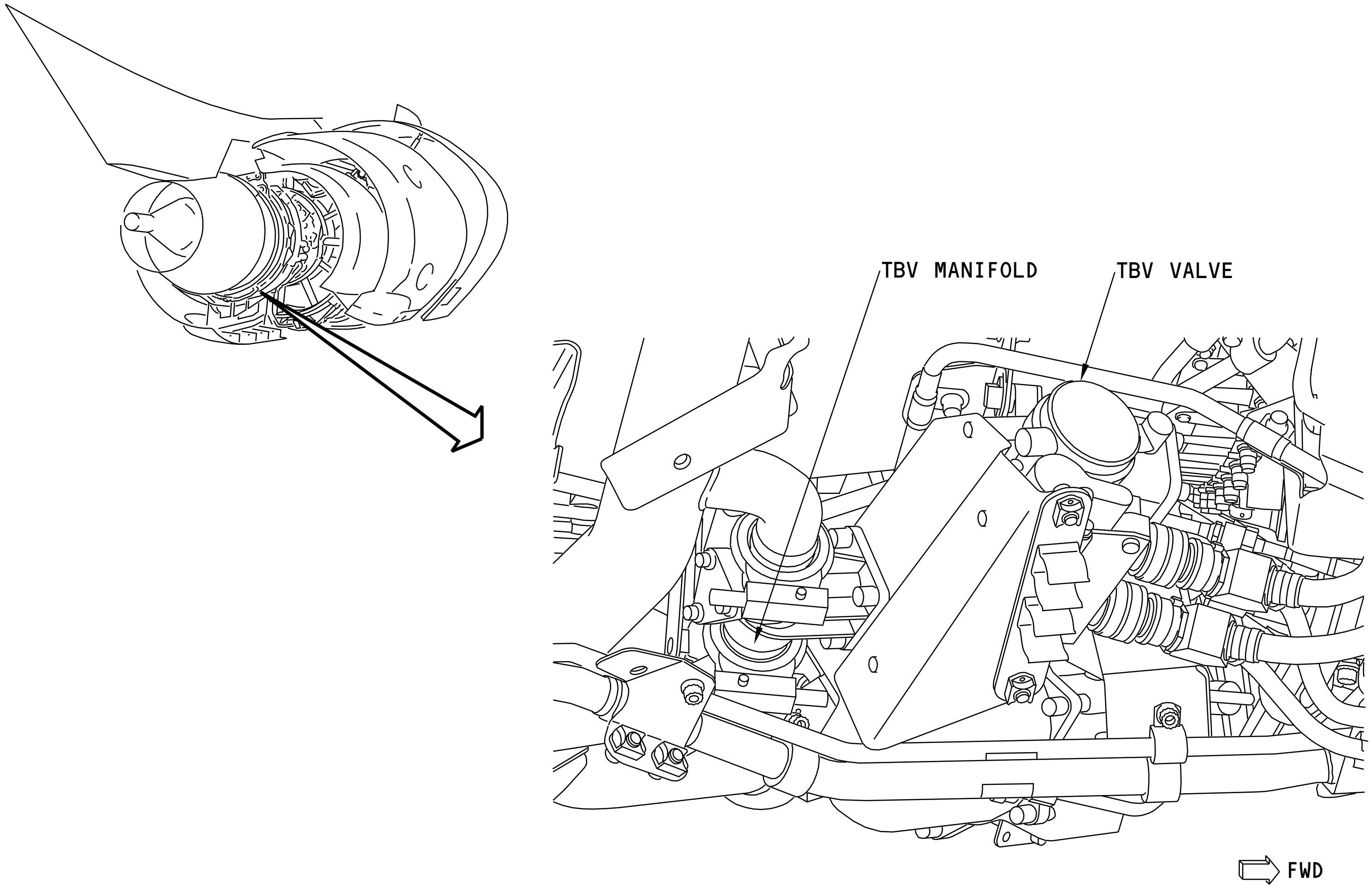
ENGINE AIR - TBV - COMPONENT LOCATION

Component Locations

These transient bleed valve (TBV) system components are on the high pressure turbine (HPT) case:

- Transient bleed valve (6:00 position)
- TBV manifold (5:00 position).

You open the two fan duct cowls and thrust reverser cowls to get access to the TBV system components.



ENGINE AIR - TBV - COMPONENT LOCATION

ENGINE AIR - TBV - TRANSIENT BLEED VALVE

Physical Description

The TBV controls the quantity of 9th stage bleed air that goes to the stage 1 LPT nozzles. The air flows from the TBV valve through the TBV manifold to the LPT case. The air then goes through holes in the LPT nozzles and mixes with the exhaust.

The TBV system has a piston type actuator. The HMU sends servo fuel pressure to the rod side and the head side of the piston in the actuator. The TBV valve has two positions, open and closed. The servo fuel pressure causes the piston to move. The piston moves the butterfly valve to the open or closed positions. The TBV actuator has a drain port to drain fuel that leaks past the rod seal.

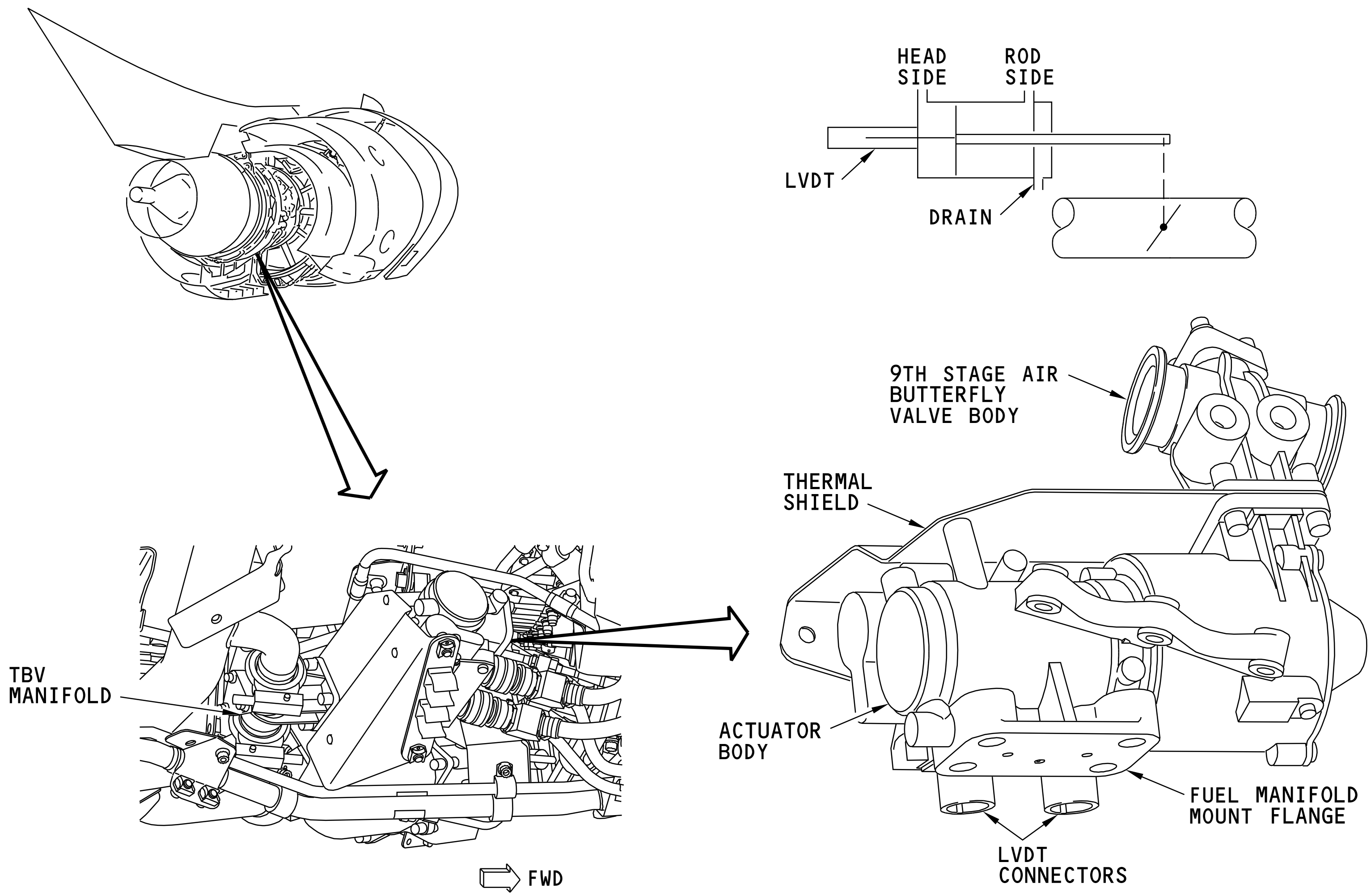
The TBV has a dual wound LVDT. This LVDT sends TBV position signals to the EEC channels A and B.

The TBV valve has these parts:

- Actuator body
- 9th stage air valve body
- LVDT connectors (2)
- Thermal shield
- Fuel manifold mount flange.

Training Information Point

You remove the TBV valve as an assembly.



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ENGINE AIR - TBV - TRANSIENT BLEED VALVE

ENGINE AIR - TBV - FUNCTIONAL DESCRIPTION

General

The EEC uses these parameters to control the transient bleed valve (TBV) position:

- N2 speed
- T25.

Operation

The EEC uses N2 speed and T25 to calculate a corrected N2 speed.

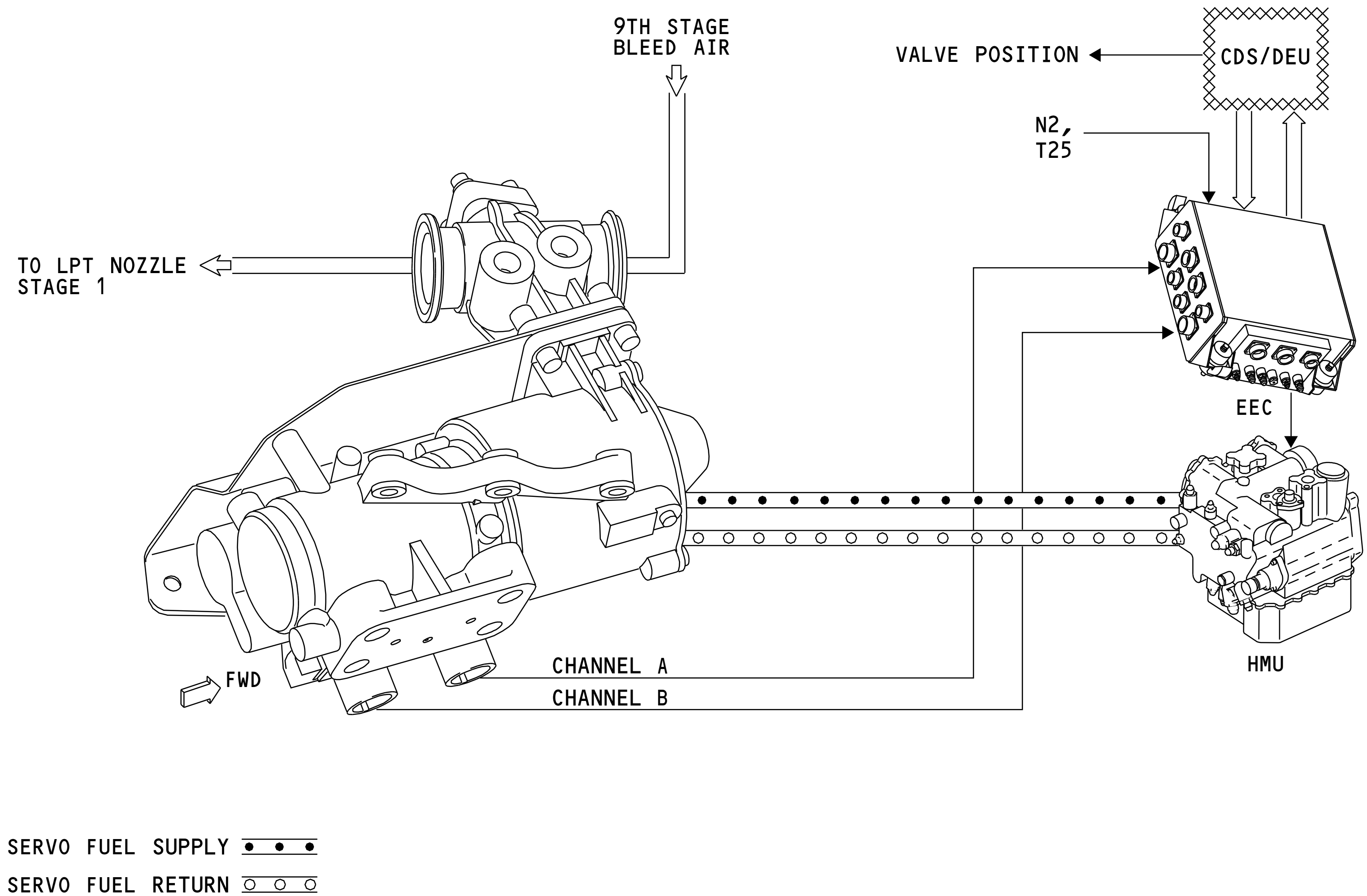
During a start sequence, the TBV opens. It closes when corrected N2 speed gets to idle.

During an engine acceleration, the TBV opens when corrected N2 speed is between idle and approximately 76 percent speed. The TBV closes when corrected N2 speed is 76 to 80 percent speed depending on T25. When corrected N2 speed is more than 80 percent, the TBV is closed during engine acceleration.

Training Information Point

You can see the TBV position in the engine maintenance pages of the control display units (CDUs).

See the engine fuel and control section for more information on the engine maintenance pages in the CDU. (SECTION 73-21)



M88027 S0004632317_V1

ENGINE AIR - TBV - FUNCTIONAL DESCRIPTION

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ENGINE AIR - VARIABLE STATOR VANE (VSV) SYSTEM - GENERAL DESCRIPTION

General Description

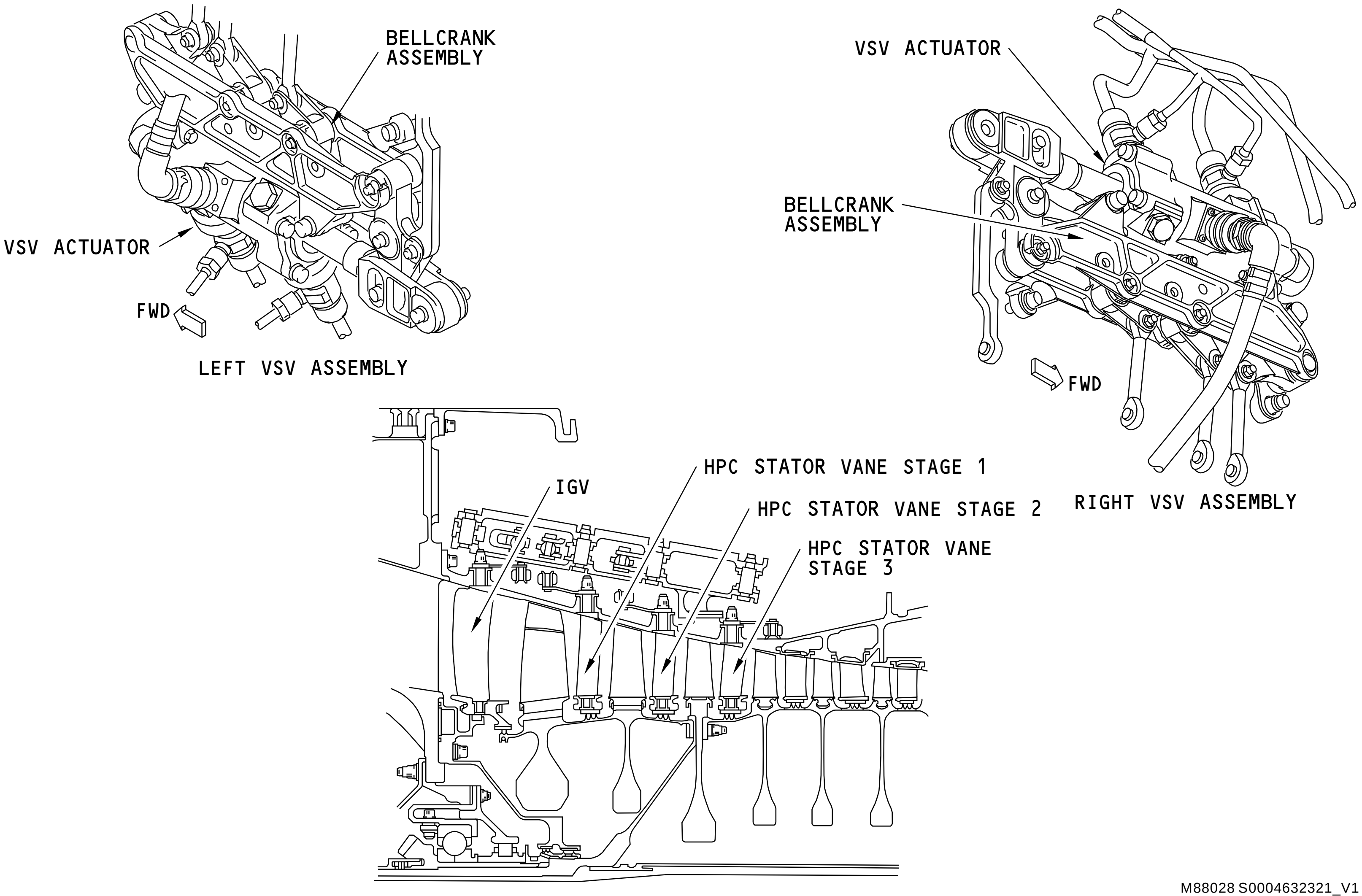
The variable stator vanes (VSV) system controls the angular position of these variable stator vanes:

- HPC Inlet guide vanes (IGV)
- HPC stator vane stage 1
- HPC stator vane stage 2
- HPC stator vane stage 3.

The VSV system adjusts the air flow in the HPC. This increases the compressor efficiency and stall margin.

The VSV system has these parts:

- Two VSV actuators
- Two bellcrank assemblies
- Four actuation rings (not shown)
- Variable stator vanes.



ENGINE AIR - VARIABLE STATOR VANE (VSV) SYSTEM - GENERAL DESCRIPTION

ENGINE AIR - VSV SYSTEM - COMPONENT LOCATION

Component Locations

These components of the variable stator vane (VSV) system are on the right side of the engine on the high pressure compressor (HPC) case at the 2:00 position:

- VSV actuator
- Bellcrank assembly.

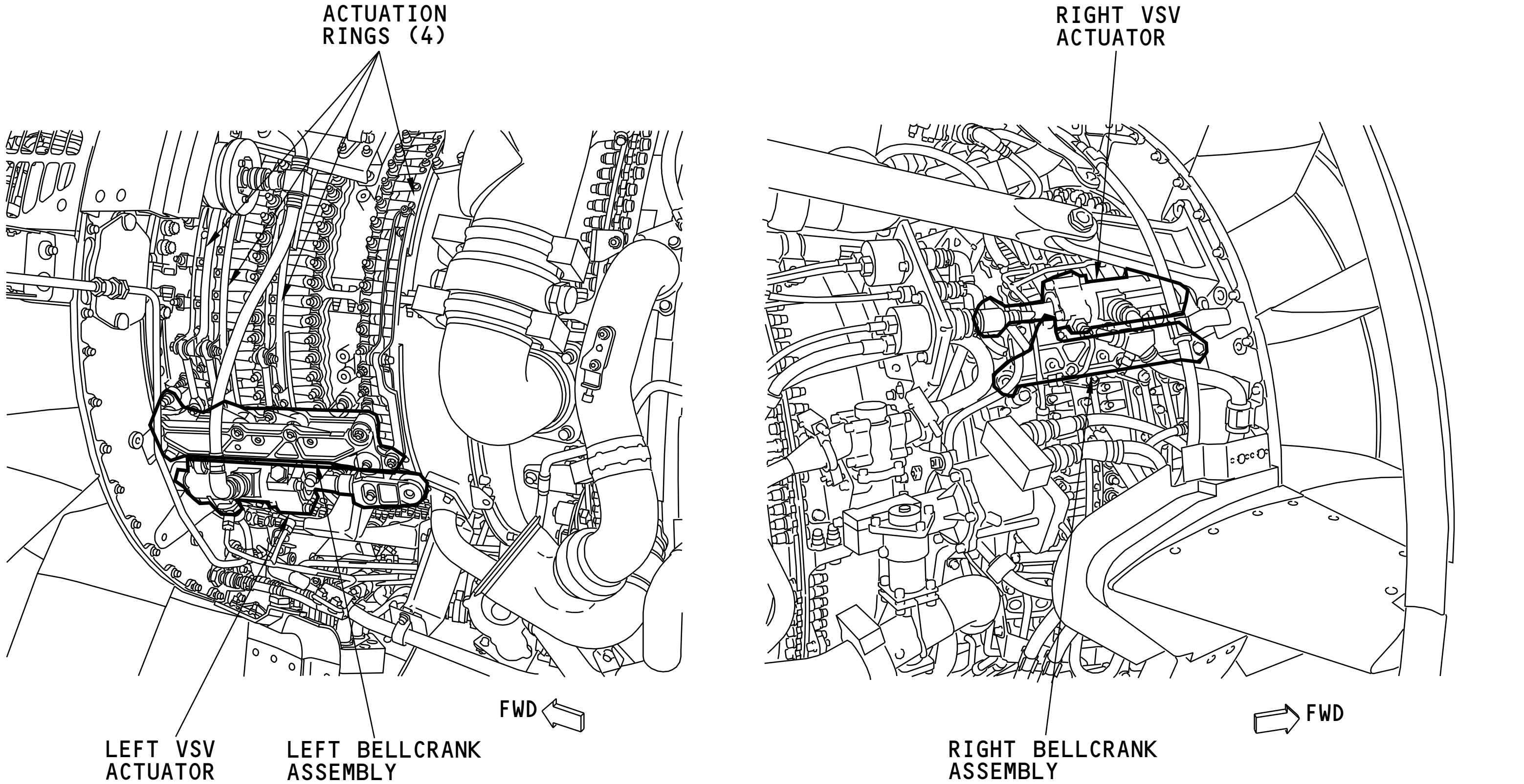
These components of the VSV system are on the left side of the engine on the HPC case at the 8:00 position:

- VSV actuator
- Bellcrank assembly.

These components of the VSV system are around and inside the HPC case:

- Actuation rings (4)
- HPC inlet guide vanes (not shown)
- HPC stator vanes stage 1 (not shown)
- HPC stator vanes stage 2 (not shown)
- HPC stator vanes stage 3 (not shown).

You open the fan cowls and thrust reversers to get access to the VSV system components.



ENGINE AIR - VSV SYSTEM - COMPONENT LOCATION

ENGINE AIR - VSV SYSTEM - ACTUATOR

Physical Description

The VSV actuators move the IGVs and the first three stages of HPC stators.

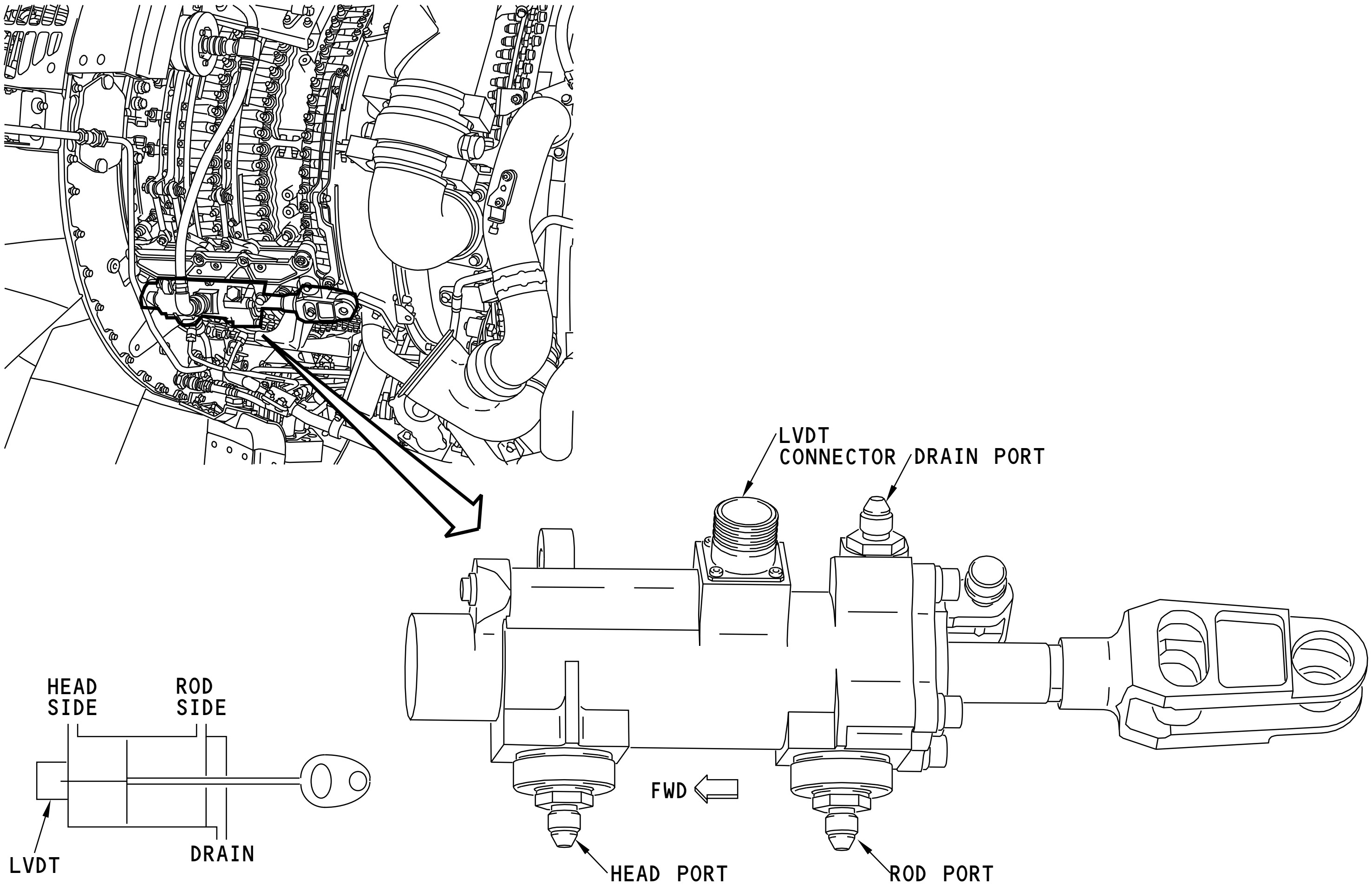
The VSV system has a piston type actuator. The HMU sends servo fuel pressure to the rod side and the head side of the piston in the actuator. The servo fuel pressure causes the piston to move. The piston moves the bellcrank. The bellcrank moves actuation rings and the actuation rings move the stator vanes. The VSV actuator has a drain port to drain fuel that leaks past the rod seal.

The LVDT of the left actuator connects to the EEC channel B. The LVDT of the right actuator connects to the EEC channel A.

Training Information Point

You can replace one actuator or both actuators. Each actuator connects to one bellcrank assembly. You disconnect the VSV actuator from the bellcrank assembly to remove it.

The VSV actuators are interchangeable.



M88030 S0004632325_V1

ENGINE AIR - VSV SYSTEM - ACTUATOR

ENGINE AIR - VSV SYSTEM - FUNCTIONAL DESCRIPTION

General

The EEC uses this data to schedule the variable stator vanes (VSV) position:

- TAT
- PT
- Ambient pressure (P0)
- N1 speed
- N2 speed
- HPC inlet air temperature (T25).

Control

The VSV system operates automatically. The EEC normally gets TAT, PT and P0 from the ADIRUs through the display electronic units (DEUs). The EEC gets the engine data from engine sensors. These parameters are used to calculate the commanded VSV position. The EEC sends a signal to the HMU. The HMU sends servo fuel pressure to the two VSV actuators. Each actuator connects to a bellcrank assembly. The two actuator and bellcrank assemblies operate together to move the variable stator vanes through 4 actuation rings. Each actuator has a LVDT. The EEC uses the LVDTs to monitor the position of the VSV actuators. One LVDT sends an electrical signal to channel A of the EEC. The other LVDT sends an electrical signal to channel B.

See the engine fuel and control section for more information on how the EEC gets TAT, PT and P0 data. (SECTION 73-21)

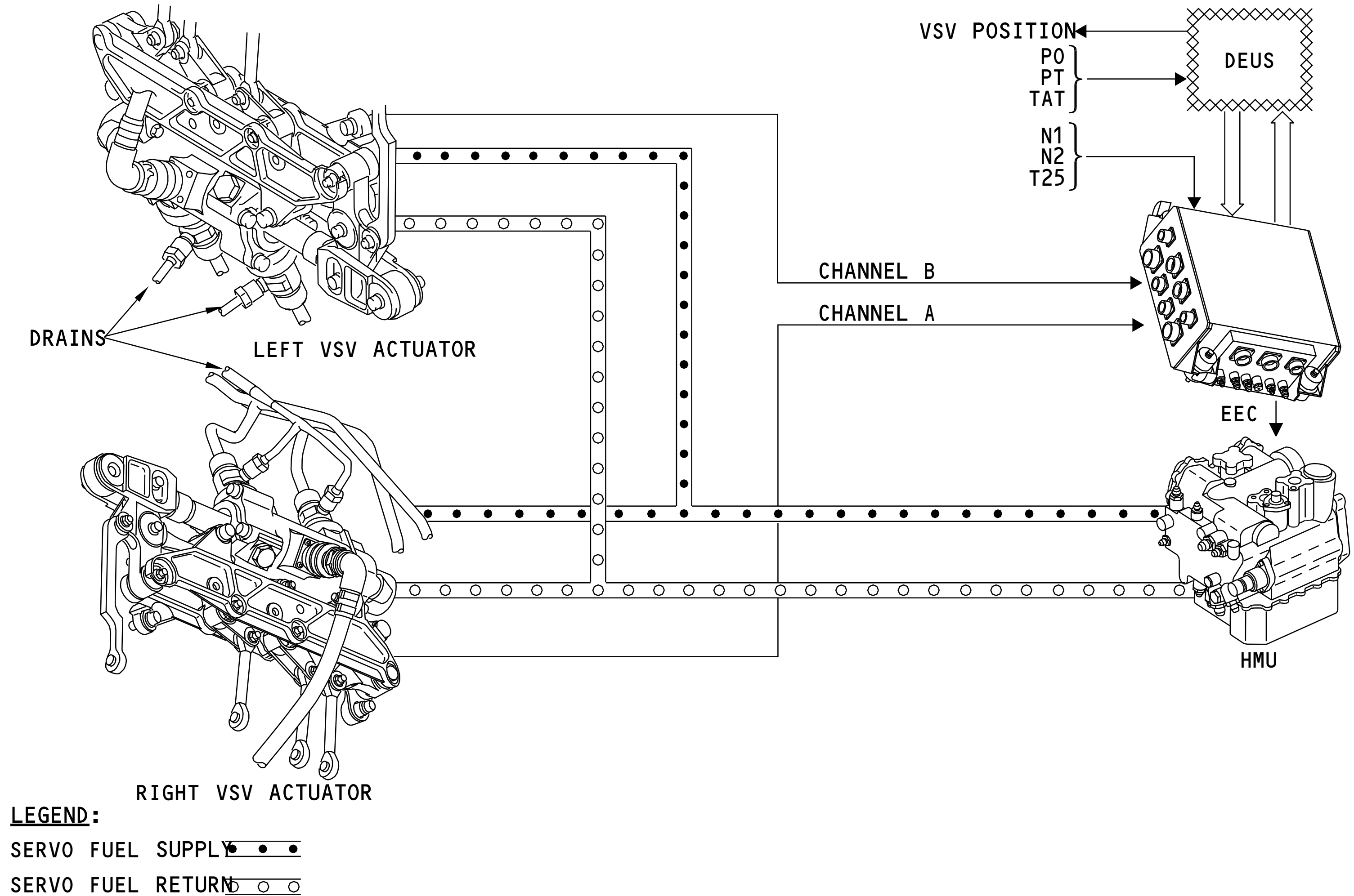
Operation

The variable stator vanes are in the closed position when N2 is at idle. They move to a more open position when N2 increases. They are at the full open position when N2 is more than 95%. The VSVs are commanded to a more closed position at lower altitudes and low TAT to improve engine stability during icing conditions. The VSVs are commanded closed when N1 or N2 speed is more than red line by more than 1 percent.

Training Information Point

You can see the VSV position in degrees on the engine maintenance pages of the control display units (CDUs).

See the engine fuel and control section for more information on the engine maintenance pages in the CDU. (SECTION 73-21)



M88031 S0004632327_V3

ENGINE AIR - VSV SYSTEM - FUNCTIONAL DESCRIPTION

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ENGINE AIR - VARIABLE BLEED VALVE (VBV) SYSTEM - GENERAL DESCRIPTION

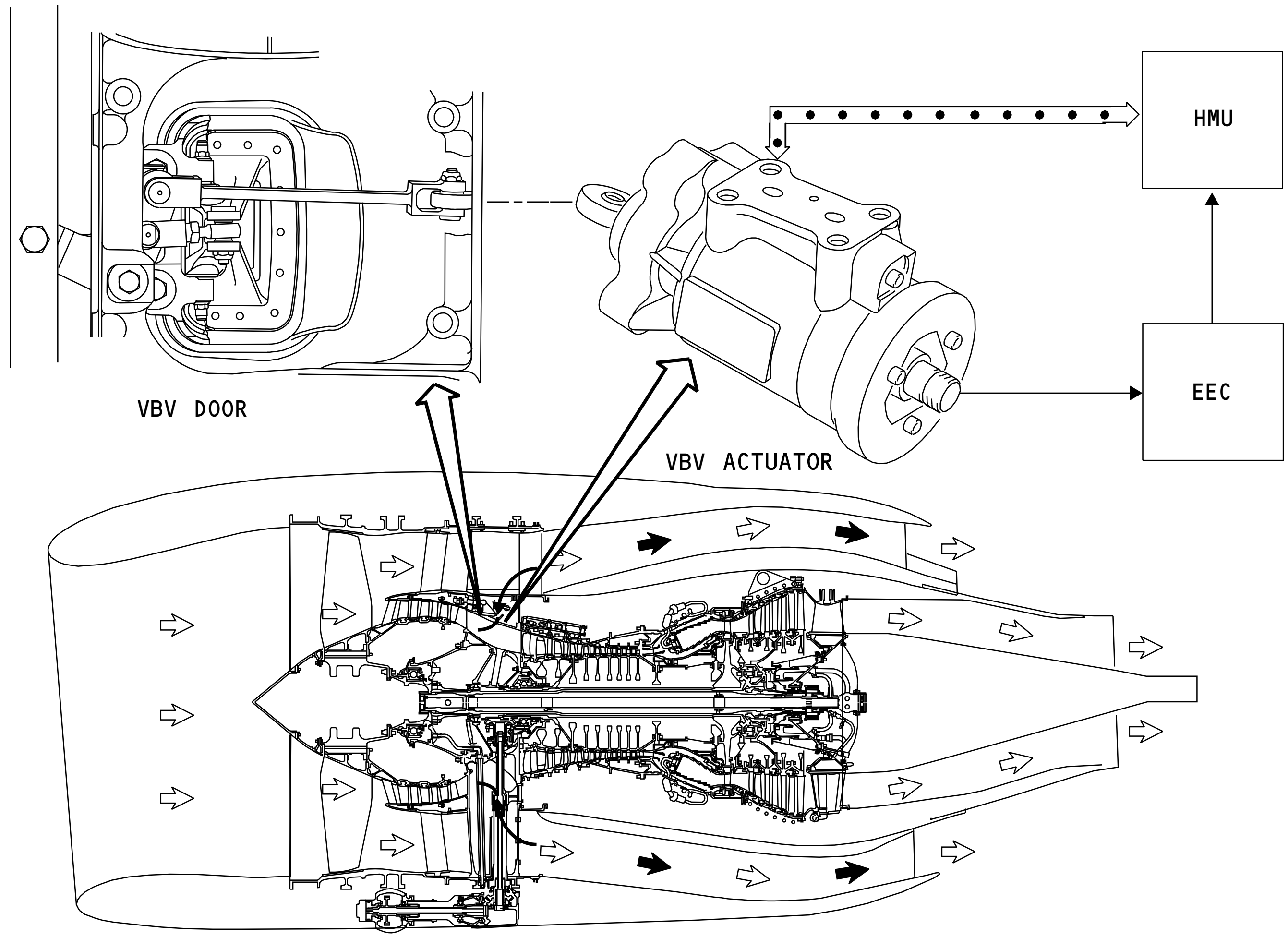
General Description

The variable bleed valve (VBV) system lets a part of the low pressure compressor (LPC) discharge air go to the secondary airflow. During a fast deceleration, the VBV system prevents an LPC stall. At low engine speed and during the thrust reverser operation, the VBV system keeps unwanted materials (such as water or gravel) out of the high pressure compressor (HPC). This prevents damage to the engine and improves engine stability.

The VBV doors control the LPC discharge air that goes into the secondary airflow.

The VBV system has these parts:

- VBV actuator (2)
- Actuation ring
- Bleed doors (10) and master bleed doors (2).



M88032 S0004632331_V1

ENGINE AIR - VARIABLE BLEED VALVE (VBV) SYSTEM - GENERAL DESCRIPTION

ENGINE AIR - VBV SYSTEM - COMPONENT LOCATION

Component Locations

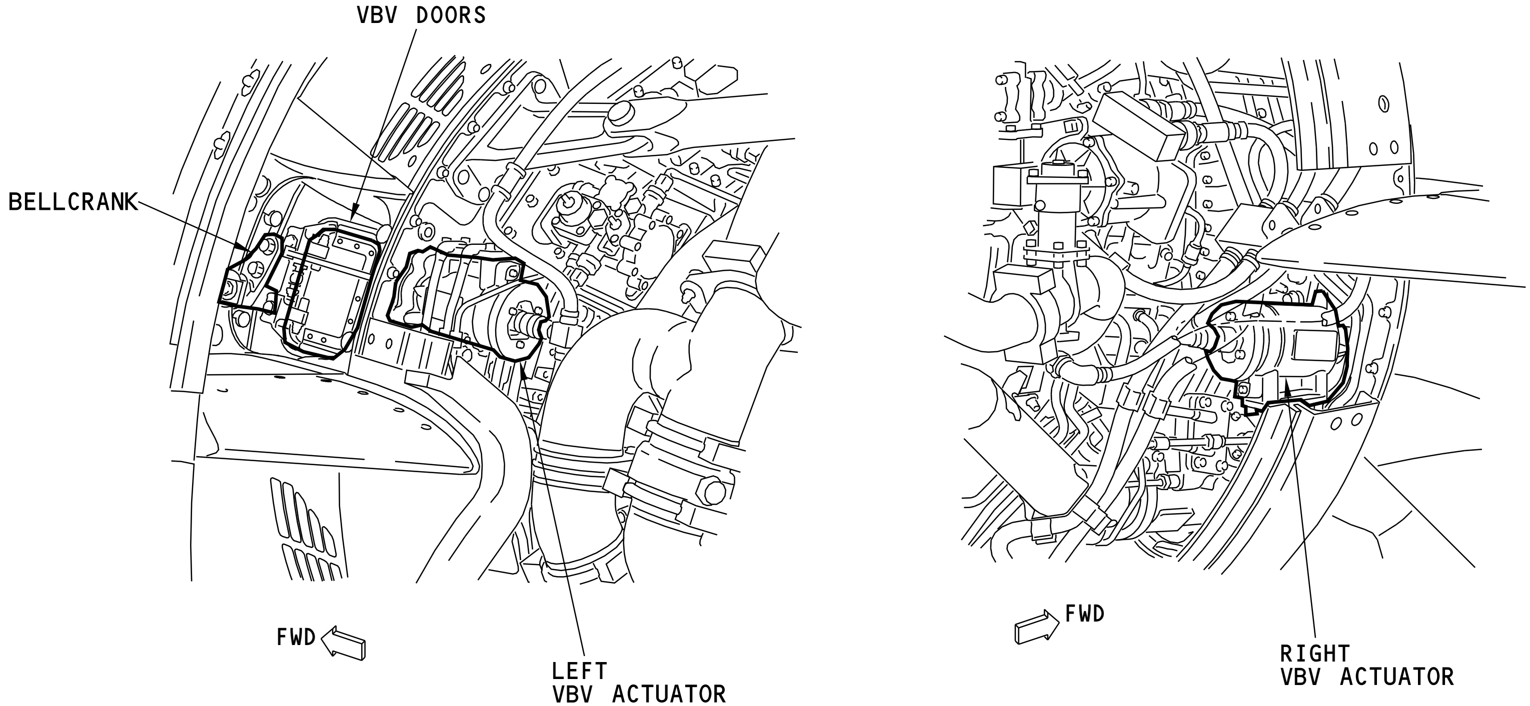
The right variable bleed valve (VBV) actuator is on the rear face of the fan frame at the 4:00 position.

The left VBV actuator is on the rear face of the fan frame at the 10:00 position.

These components are in the fan frame:

- VBV door (12)
- Actuation ring (not shown)
- Bellcrank (12).

You open the two fan cowls and thrust reverser cowls to get access to the VBV system components.



M88008 S0004632333_V1

ENGINE AIR - VBV SYSTEM - COMPONENT LOCATION

ENGINE AIR - VBV SYSTEM - ACTUATOR

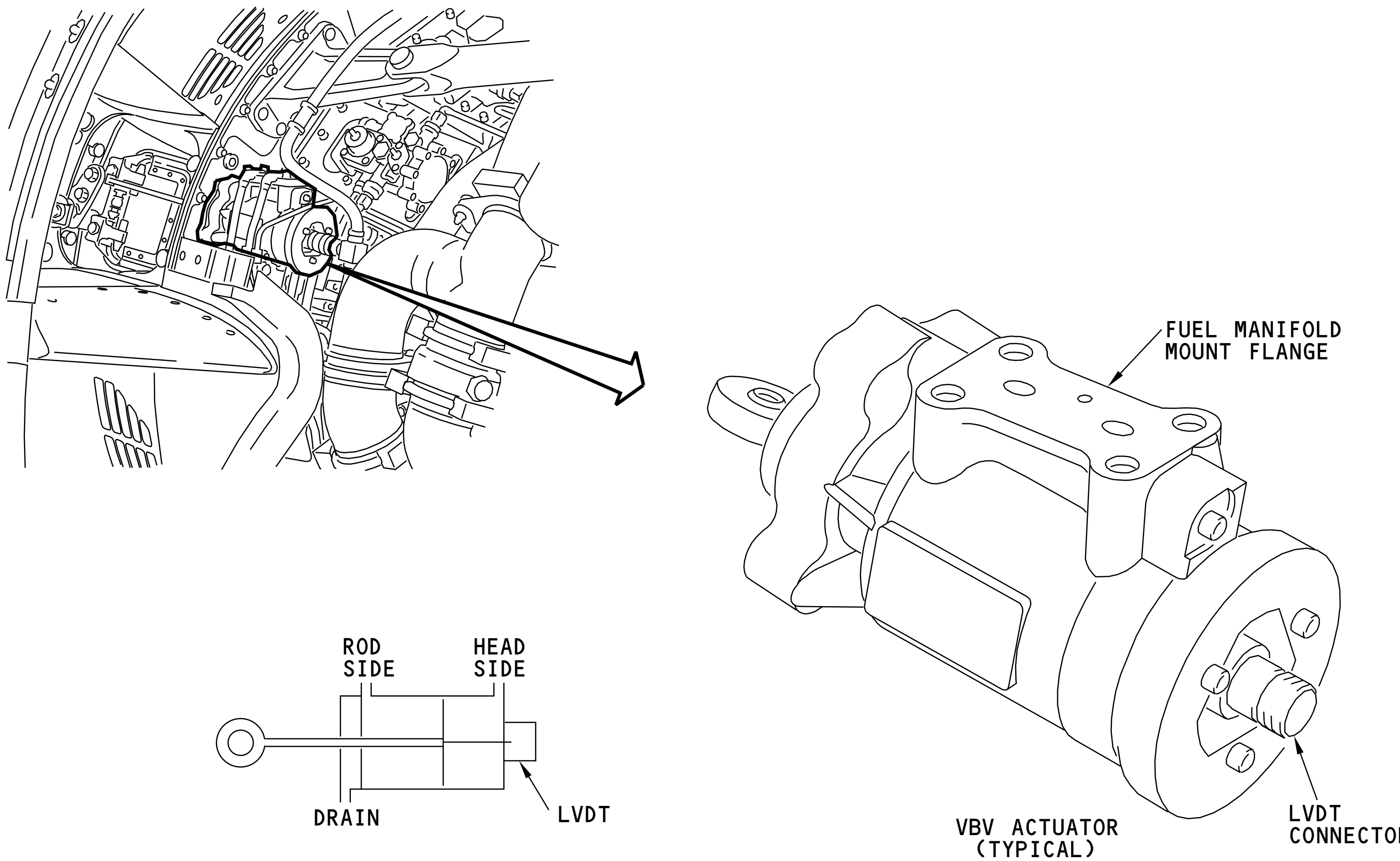
Physical Description

The VBV actuator is a piston type actuator. The HMU sends servo fuel pressure to the head and rod side of the piston to move the piston to the commanded position. Each actuator has a fuel manifold mount flange to connect with the hydromechanical unit (HMU). There is one LVDT connector for each actuator. The LVDT of the left actuator connects to EEC channel B. The LVDT of the right actuator connects to EEC channel A.

The VBV actuator has a drain port to drain fuel that leaks from the shaft seal.

Training Information Point

To disconnect an actuator, you must remove a fan duct panel. The VBV actuators are interchangeable.



M88033 S0004632335_V1

ENGINE AIR - VBV SYSTEM - ACTUATOR

ENGINE AIR - VBV SYSTEM - DOORS

General Description

The VBV doors control the quantity of low pressure compressor (LPC) air that mixes with the fan discharge air flow.

Physical Description

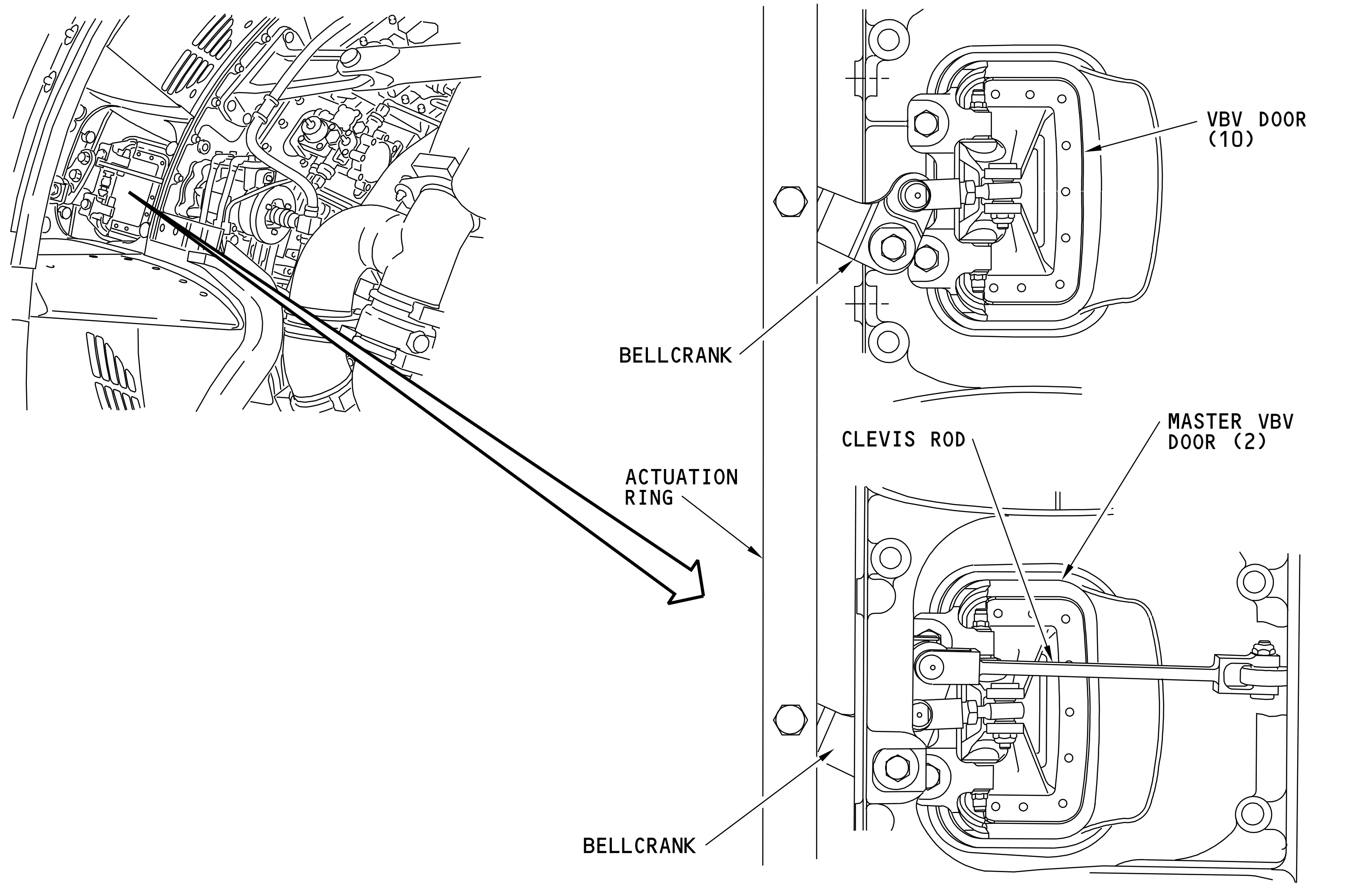
There are twelve VBV doors. Each door connects to the actuation ring through a bellcrank. Two of the doors are called master doors. The VBV actuators connect to the bell cranks for the master doors. The VBV doors operate when the two VBV actuators move the master door bellcranks. The master doors bellcranks then move the actuation ring and the other VBV doors.

Training Information Point

You can replace one or more VBV doors. You remove a fan duct panel to get access to a VBV door.

The two master VBV doors with a longer bellcrank are interchangeable.

The ten other VBV doors are interchangeable.



ENGINE AIR - VBV SYSTEM - DOORS

ENGINE AIR - VBV SYSTEM - FUNCTIONAL DESCRIPTION

General

The EEC uses these data to schedule the variable bleed valves (VBVs) position:

- P0
- PT
- TAT
- T25
- VSV position
- N1 speed
- N2 speed
- Thrust lever resolver angle (TRA).

Control

The VBV system operates automatically. The EEC normally gets P0, PT and TAT from the ADIRUs through the DEUs. The EEC gets N1, N2, T25 and VSV position from engine sensors and TRA from the thrust lever resolver. The EEC uses this data to schedule an angular position for the VBV doors. The EEC sends a command signal to the HMU. The HMU sends servo fuel pressure to move the pistons in the two VBV actuators. The actuators connect with the twelve VBV doors through an actuation ring. The VBVs control the amount of LPC discharge air that goes to the secondary airflow.

Each actuator has a LVDT. The EEC uses the LVDTs to monitor the position of the actuators. One LVDT sends an electrical signal to channel A of the EEC. The other LVDT sends an electrical signal to channel B.

Operation

In general, during steady state operation, the VBVs go more closed as N1 speed increases. The VBVs are closed above about 80 percent N1 speed.

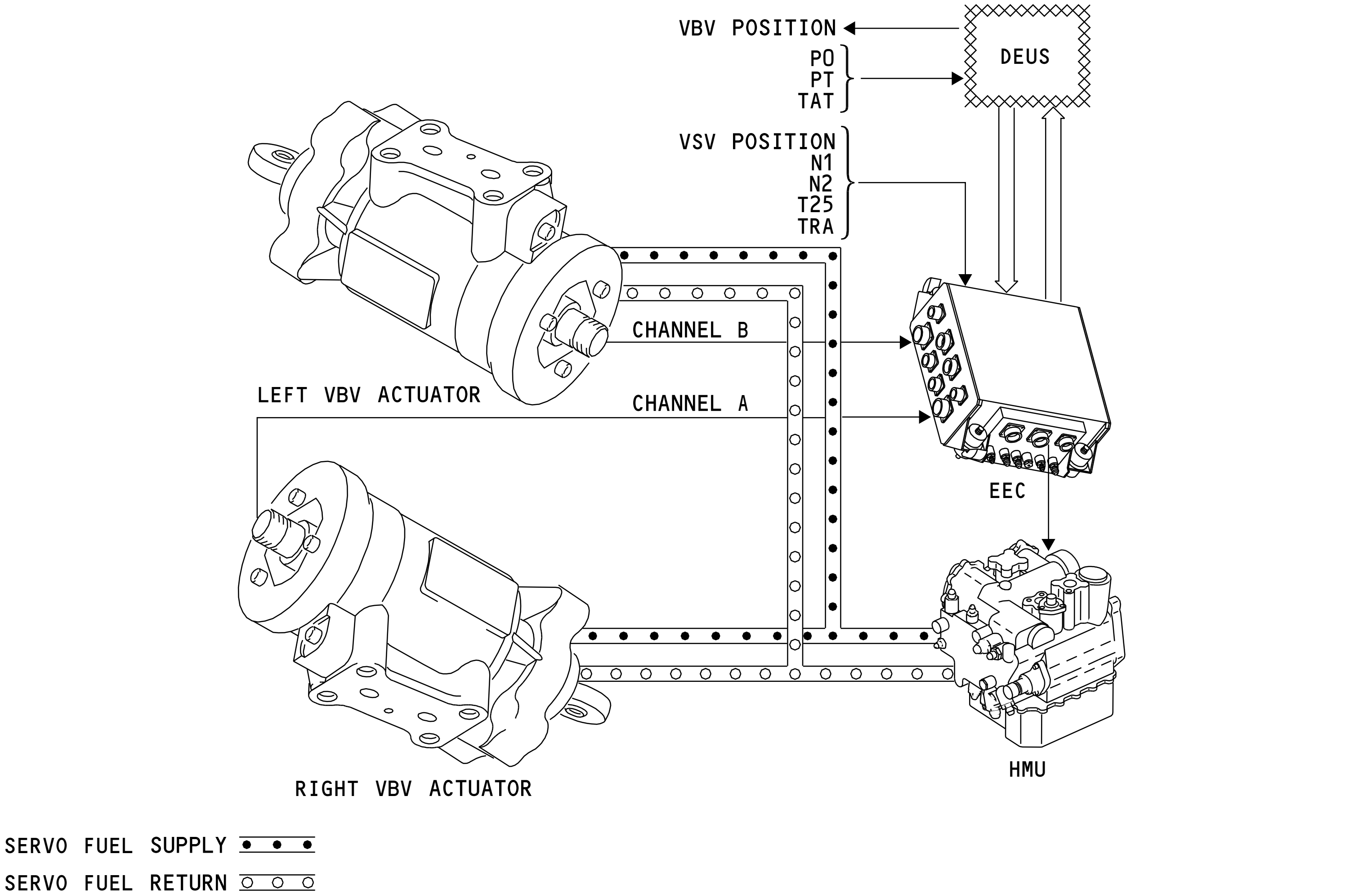
The EEC commands the VBV doors to be more open during these conditions:

- Rapid engine deceleration
- Thrust reverser operation
- Potential icing conditions.

Training Information Point

You can see VBV door position in the engine maintenance pages of the control display unit (CDU).

See the engine fuel and control section for more information on the engine maintenance pages in the CDU. (SECTION 73-21)



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ENGINE AIR - VBV SYSTEM - FUNCTIONAL DESCRIPTION