CHAPTER

75

Engine Air GE 115

(GE90-100 SERIES ENGINES)

CHAPTER 75
ENGINE AIR GE 115

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ENGINE AIR GE 115

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

75-EFFECTIVE PAGES

CHAPTER 75
ENGINE AIR GE 115

75-CONTENTS

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ENGINE AIR - INTRODUCTION

Purpose

The engine air system controls the cooling air to the engine and the airflow through the compressors.

These are the engine air sub-systems:

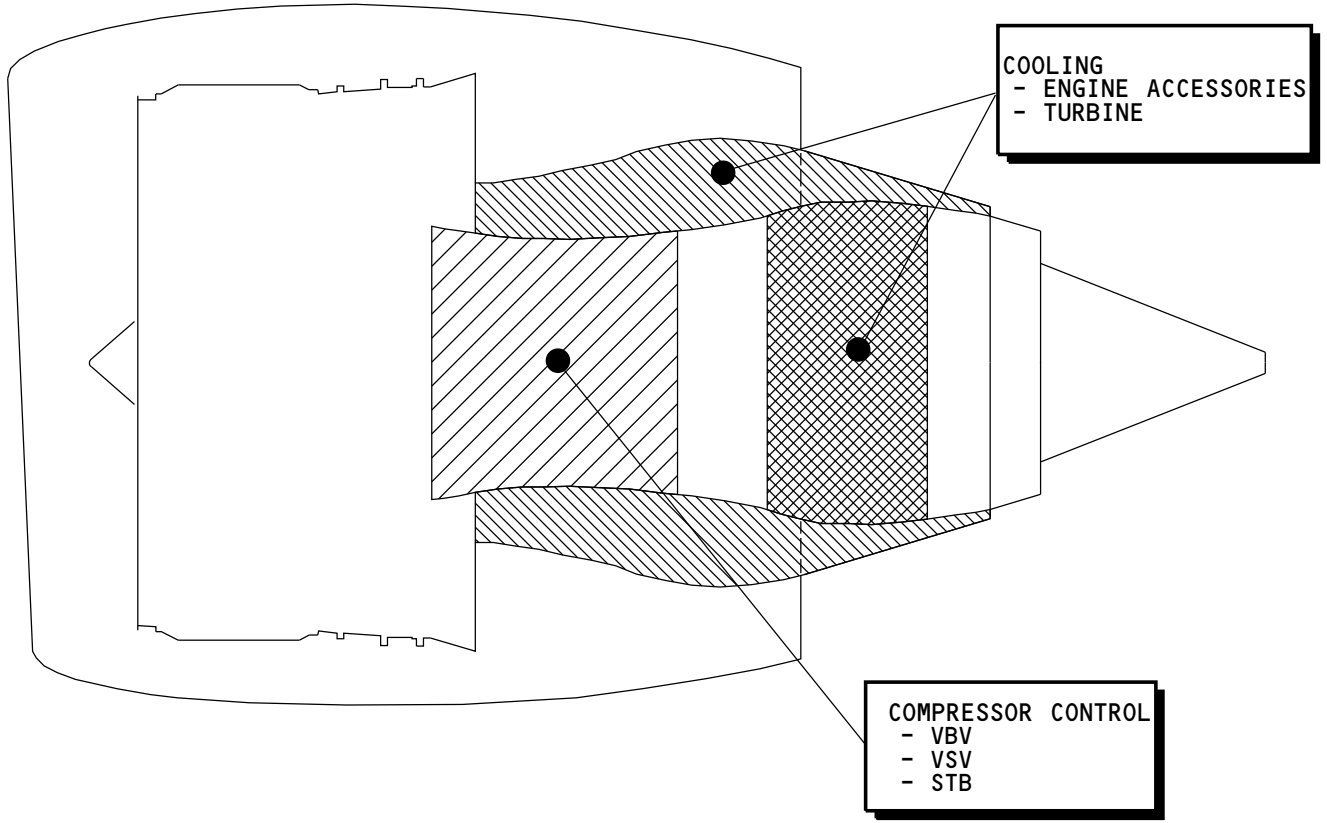
- Cooling system
- Compressor control system.

The cooling system supplies air to cool the engine accessories and turbine case.

The compressor control system controls the airflow through the low pressure compressor (LPC) and high pressure compressor (HPC).

Abbreviations and Acronyms

- ACTR - actuator
- AIMS - airplane information management system
- ARINC - aeronautical radio, incorporated
- CCC - core compartment cooling
- EDIU - engine data interface unit
- EEC(FADEC) - electronic engine control (full authority digital electronic control)
- EGT - exhaust gas temperature
- EHSV - electrohydraulic servo valve
- EPCS - electronic propulsion control system
- FOD - foreign object damage
- FDBK - feedback
- HMU - hydromechanical unit
- HPC - high pressure compressor
- HPTACC - high pressure turbine active clearance control
- IGV - inlet guide vane
- LPC - low pressure compressor
- LPTACC - low pressure turbine active clearance control
- LVDT - linear variable differential transformer
- MAT - maintenance access terminal
- MFD - multi-function display
- OVBD - overboard
- PDS - primary display system
- STB - start/transient bleed
- SW - switch
- T/R - thrust reverser
- VBV - variable bypass valve
- VSV - variable stator vane



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ENGINE AIR - INTRODUCTION

ENGINE AIR - GENERAL DESCRIPTION

General

The engine air system has two subsystems:

(1) Engine Air Cooling

(2) Engine Compressor Control.

The Electronic Engine Control (EEC) controls the engine air system components. The engine air system component positions and faults show on the Primary Display System (PDS).

Engine Air Cooling

These are the engine air cooling subsystems:

(1) Engine Accessory Cooling

(2) Turbine cooling system.

Engine accessory cooling uses fan or LPC air to keep core components cool. The EEC controls the Core Compartment Cooling (CCC) valve. Seventh stage servo air operates the CCC valve.

The turbine cooling system uses fan air to cool the turbine cases. This makes the turbine case smaller and decreases the clearance between the turbine blade tips and the turbine case. The smaller clearance increases engine efficiency.

The low pressure turbine Active Clearance Control (ACC) valve permits fan air blow on the LPT case. The EEC controls the LPT ACC valve. Seventh stage servo air operates the valve.

The High Pressure Turbine (HPT) Active Clearance Control (ACC) valve permits fan air blow on the HPT case. The EEC controls a torque motor in the HMU to operate the HPT ACC valve. The torque motor sends servo fuel pressure to the valve actuator.

Compressor Control System

The compressor control system matches Low Pressure Compressor (LPC) and High Pressure Compressor (HPC) airflows for all power conditions. This helps prevent an engine stall.

These are the compressor control subsystems:

(1) Variable Bypass Valve System

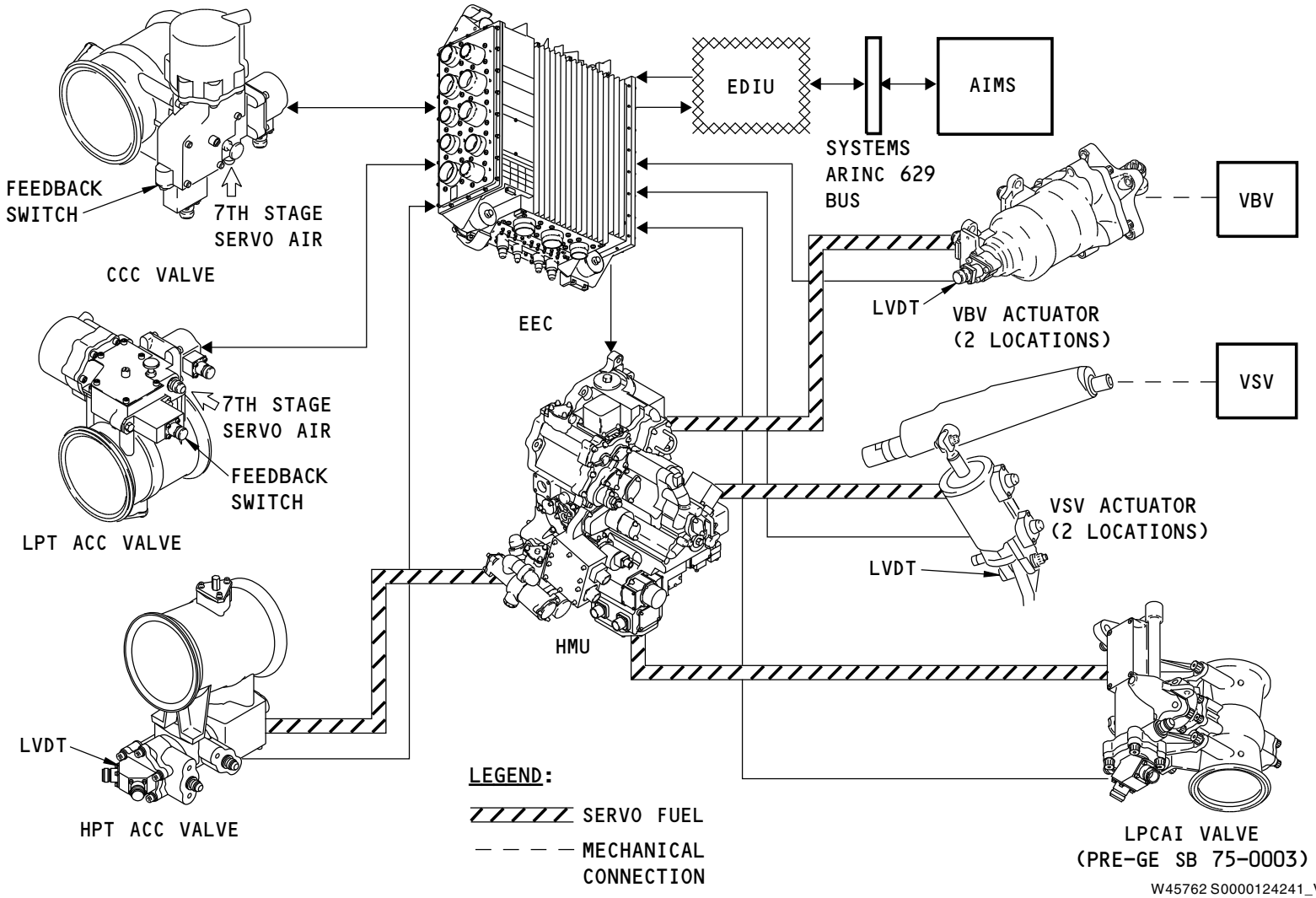
(2) Variable Stator Vane System.

The VBV system sends air from the LPC exit into the fan stream. This decreases the amount of air going into the HPC. The EEC controls a torque motor in the HMU to operate the VBVs. The torque motor sends servo fuel pressure to two VBV actuators. The actuators move 10 bypass valves

The VSV system moves HPC stator vanes to control HPC airflow. The EEC controls a torque motor in the HMU to operate the VSVs. The torque motor sends servo fuel pressure to two VSV actuators. The VSV system moves the HPC inlet guide vanes (IGV) and the 1st through 4th stage stator vanes. The torque motor sends fuel pressure to the VSV actuators to turn the torsion bars. The torsion bars move unison rings on the HPC. The unison rings connect to the stator vanes.

Indication and Control

The valves and actuators send feedback data to the EEC. The EEC uses the feedback data for control and indication. The AIMS receives position data from the EEC to show on the PDS.



ENGINE AIR - GENERAL DESCRIPTION

ENGINE AIR - COMPONENT LOCATION - LEFT

Component Locations - Left Side

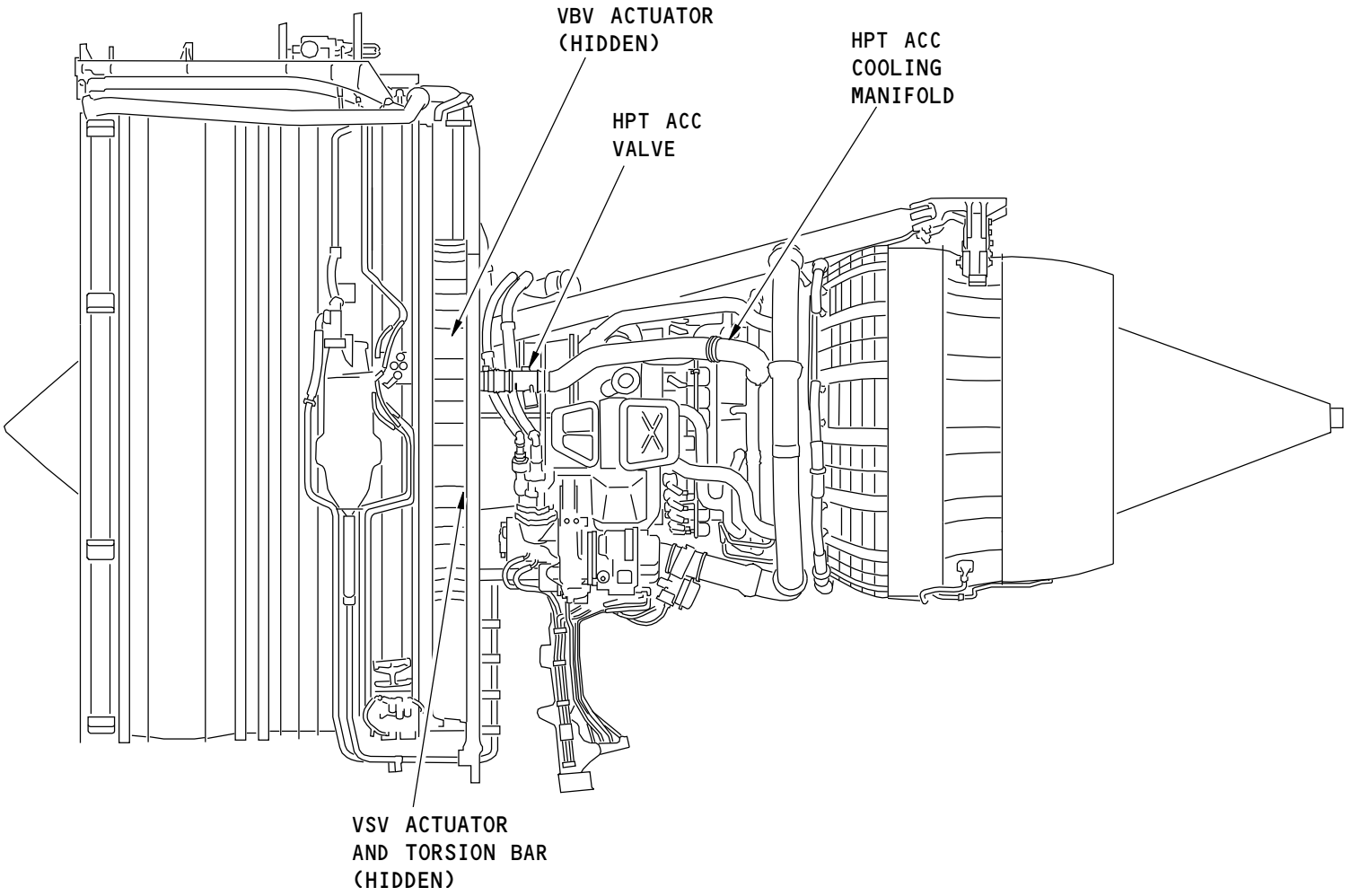
These engine air cooling and compressor control components are on the left side of the engine core:

(1) HPT ACC valve

(2) HPT ACC cooling manifold

(3) VBV actuator

(4) VSV actuator and torsion bar.



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ENGINE AIR - COMPONENT LOCATION - LEFT

ENGINE AIR - COMPONENT LOCATIONS - RIGHT

Component Locations - Right Side

These engine air cooling and compressor control components are on the right side of the engine core:

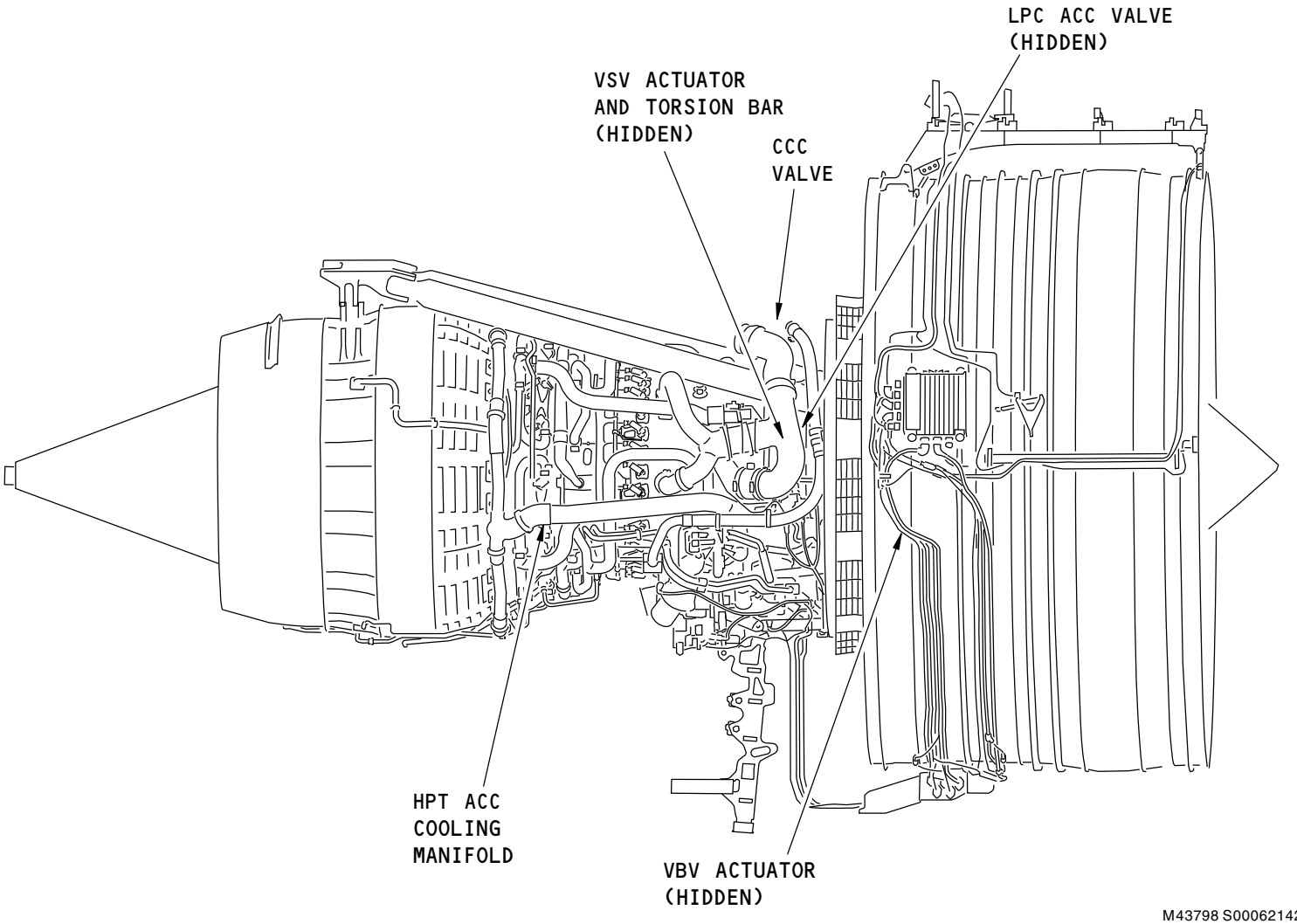
(1) VSV Actuator and Torsion Bar

(2) CCC Valve

(3) VBV Actuator

(4) LPT ACC Valve

(5) LPT ACC Cooling Manifold.



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ENGINE AIR - COMPONENT LOCATIONS - RIGHT

ENGINE AIR - FUNCTIONAL DESCRIPTION

General

The EEC automatically controls the engine air system to cool engine components and to improve compressor operation.

Valves control fan bypass air for cooling. Bleed valves and variable stator vanes control the compressor.

The EEC uses engine and airplane data to control the air system. The EEC also sends valve and stator vane position and system faults through the EDIU to the AIMS.

Cooling

These valves control engine cooling air:

- CCC valve
- LPT ACC valve
- HPT ACC valve.

Cooling air goes through the CCC valve to cool the area between the engine core and the thrust reverser cowl. The valve closes during cruise to improve engine efficiency. Channel B of the EEC controls the valve. Servo air operates the valve.

Fan air goes through the LPT ACC and HPT ACC valves to cool the LP and HP turbine cases. Channel A of the EEC controls the LPT ACC valve. Servo air actuates the valve. The EEC controls a torque motor in the HMU to operate the HPT ACC valve. Servo fuel actuates the valve.

Compressor Control

These components control airflow through the compressor:

- VBVs
- VSVs
- STB valve.

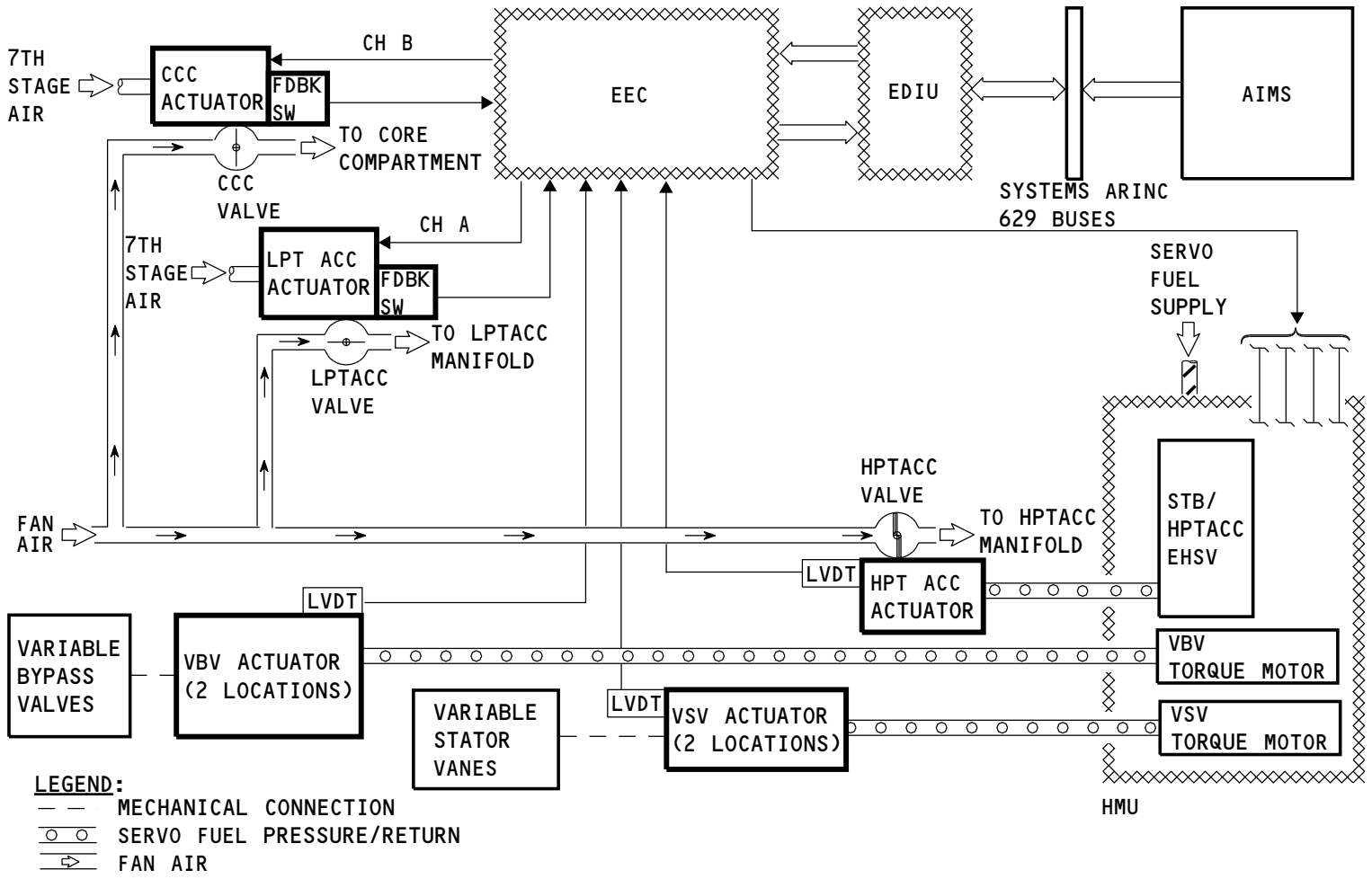
The EEC controls torque motors in the HMU to operate the VBVs, VSVs and the STB valve. Servo fuel actuates the components.

The EEC controls torque motors in the HMU to operate the VBVs and VSVs. Servo fuel actuates the components.

The VBVs open to bleed air from the LPC to the fan duct. The VBVs open at low power and move closed at high power.

The VSVs control airflow through the HPC with variable stators. The VSVs are closed at low power and move to open at high power.

Feedback switches or LVDTs on the valves and actuators send valve and actuator position signals to the EEC.



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ENGINE AIR - FUNCTIONAL DESCRIPTION

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ENGINE AIR - ENGINE ACCESSORIES COOLING - GENERAL DESCRIPTION

General

The engine accessories cooling system uses air from the LPC or the fan stream to cool the core compartment. When the VBVs are open, LPC air cools the core compartment. When the VBVs close, fan air cools the core compartment. The cooling air goes through the CCC valve.

The EEC sends engine accessory cooling faults to the AIMS.

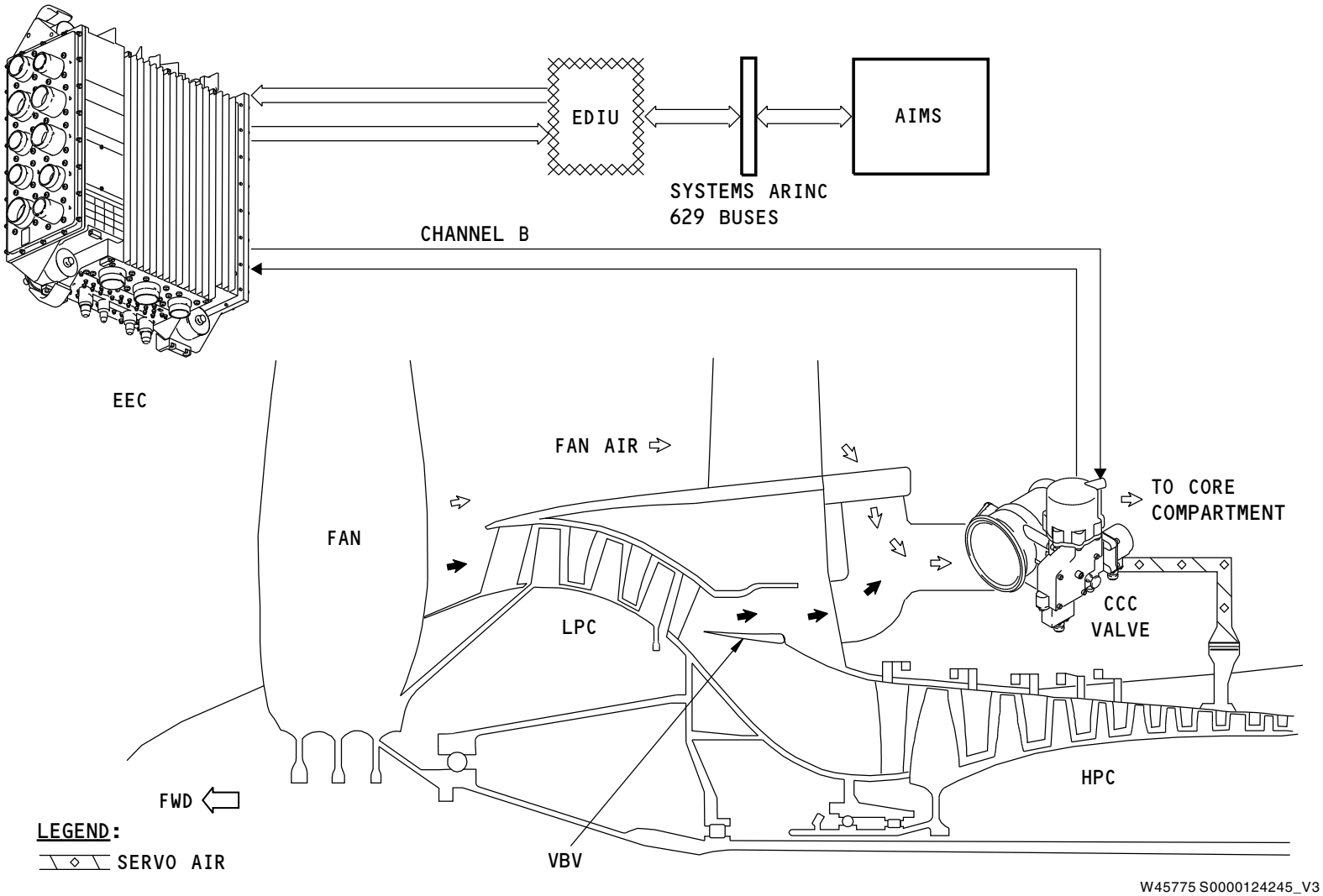
CCC Control

Channel B of the EEC controls a solenoid on the CCC valve to operate the valve. When the solenoid energizes, 7th stage servo air goes to the valve actuator to close the valve.

When the airplane is at cruise, the valve closes to increase engine efficiency. At all other times the valve is open. The EEC uses altitude and N1 to find when the airplane is at cruise. The CCC valve permits low air flow when it is closed.

Position Feedback

A feedback switch on the CCC valve sends a valve position signal to each channel of the EEC. You can see the CCC valve position on the EPCS maintenance page. The position shows OPEN or CLOSED.



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ENGINE AIR - ENGINE ACCESSORIES COOLING - GENERAL DESCRIPTION

ENGINE AIR - ENGINE ACCESSORIES COOLING - CORE COMPARTMENT COOLING VALVE

Purpose

The CCC valve controls the cooling air to the engine core compartment and the aft face of accessory gearbox.

Location

The CCC valve is on the forward engine core at the 1:00 position. You must open the right thrust reverser (T/R) to get access to the CCC valve.

Physical Description

The CCC valve has solenoid control and pneumatic actuation. The valve has two positions: open or closed. The CCC valve has these parts:

- Solenoid
- Lockout control
- Servo air connector
- Valve position indicator
- Feedback switch.

The CCC valve feedback switch is line replaceable.

Functional Description

The CCC valve inlet connects to the VBV duct. The CCC valve outlet connects to the CCC air distributor duct.

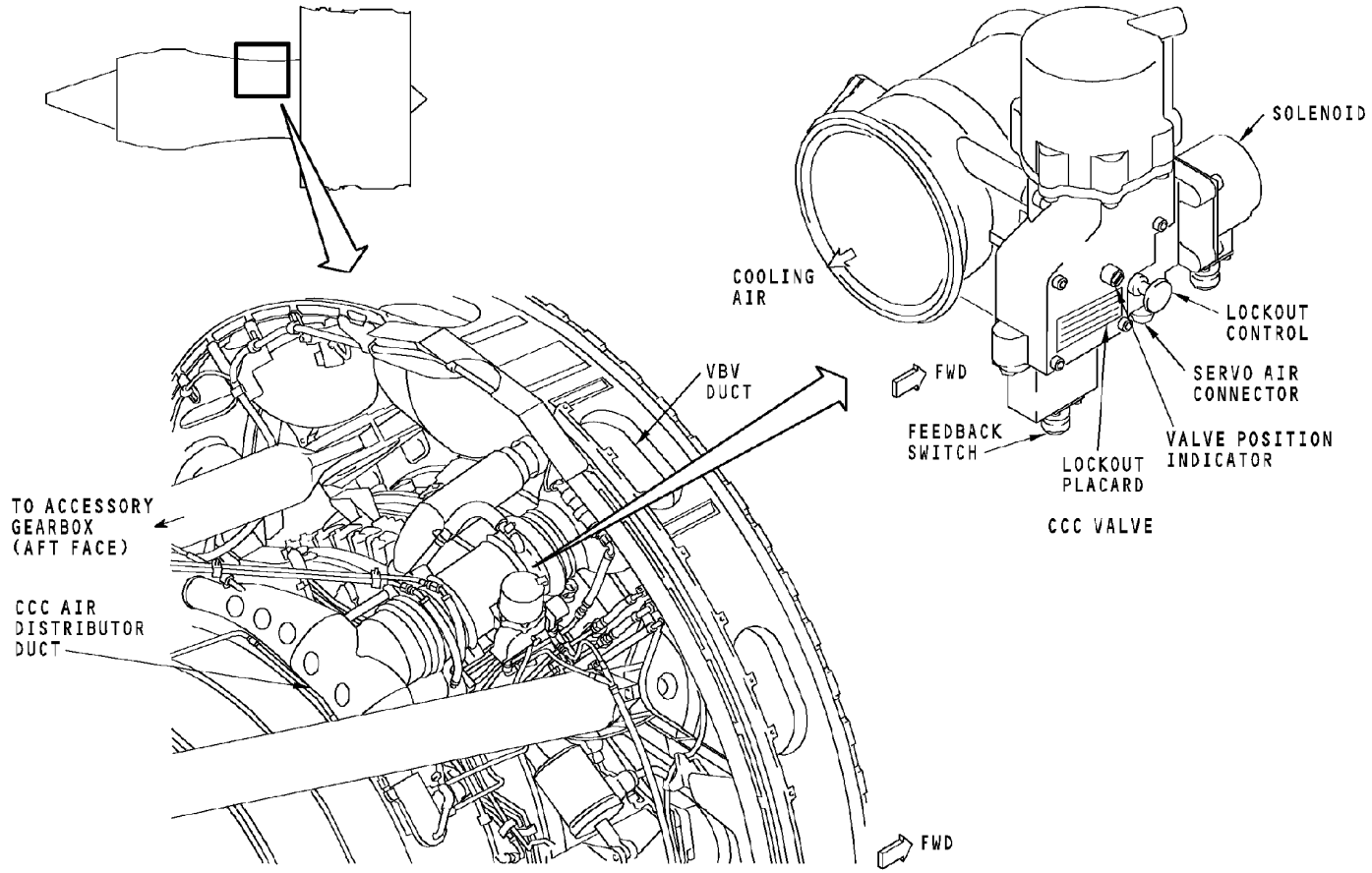
The cooling air flows out of the CCC air distributor duct into the core compartment. A connecting duct also sends cooling air to the aft face of the accessory gearbox. The cooling air goes overboard through vents in the cowling.

Training Information Point

A placard on the CCC valve tells you how to lock the valve open. You use a tool in a slot in the valve position indicator to move the valve. You turn the lockout control on the valve to lock it open.

The servo air line attaches to the CCC valve actuator with a B-nut. Observe this note when you tighten the B-nut:

NOTE: Use the instruction for torque to tighten the B-nut (AMM 70-51-00/201).



ENGINE AIR - ENGINE ACCESSORIES COOLING - CORE COMPARTMENT COOLING VALVE

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ENGINE AIR - TURBINE COOLING - GENERAL DESCRIPTION

General

The turbine cooling system uses fan air to cool the LPT and HPT turbine cases. This makes the turbine cases smaller and decreases the clearance between the turbine blade tips and the turbine case. The smaller clearance increases engine efficiency.

The turbine cooling system has two subsystems:

(1) LPT ACC System

(2) HPT ACC system.

Each system has a valve that permits fan air to go through a duct to the turbine case. The duct puts the air into a manifold that goes around the turbine case. The inside of the manifold has holes that blow air onto the turbine case.

The EEC sends turbine cooling system faults to the AIMS.

LPT ACC System

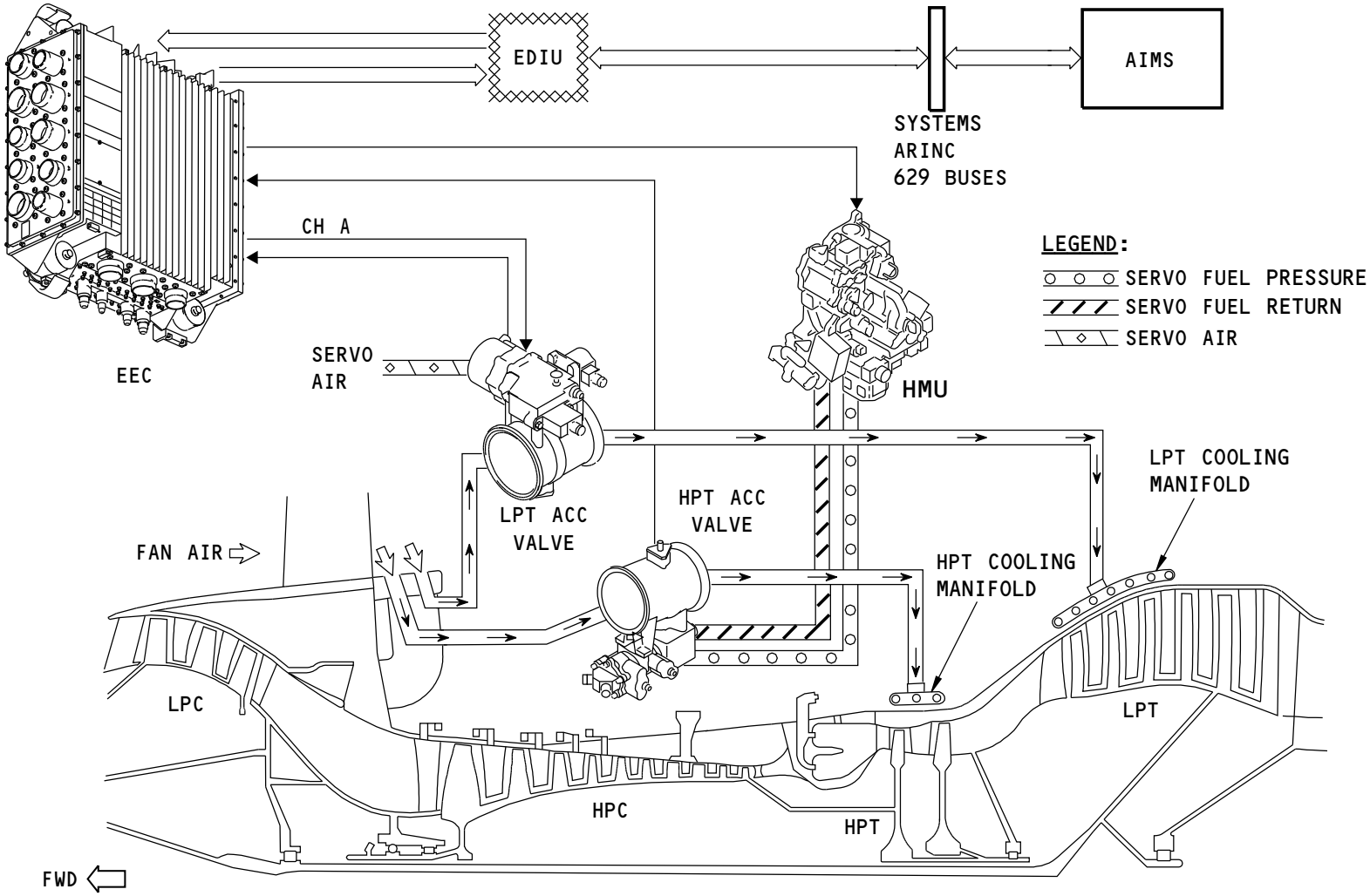
The EEC only uses channel A to control the LPT ACC valve. When the EEC energizes the LPT ACC valve solenoid, 7th stage servo air opens the valve. The valve permits full flow when it opens, and low flow when it closes. The EEC uses N1 and altitude to control the valve. The valve opens when the engine goes to takeoff thrust, and stays open through the climb and cruise flight phases.

A feedback switch on the LPT ACC valve sends a valve position signal to each channel of the EEC. You can see the valve position on the EPCS maintenance page (not shown). The valve position shows OPEN or CLOSED.

HPT ACC System Functional Description

The EEC controls a torque motor in the HMU to modulate the HPT ACC valve. The EEC controls the torque motor based on inlet temperature, N1, and N2. The torque motor sends servo fuel pressure to the HPT ACC valve actuator to move the valve. When the valve opens, fan air blows on the HPT case. The valve opens for a short time after the engine goes to takeoff thrust. The valve modulates during engine operation. The valve permits low flow when it closes.

A dual LVDT on the valve sends a valve position to each channel of the EEC. You can see the valve position on the EPCS maintenance page (not shown). The valve position shows in percent open.



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ENGINE AIR - TURBINE COOLING - GENERAL DESCRIPTION

ENGINE AIR - TURBINE COOLING - LPT ACTIVE CLEARANCE CONTROL VALVE

Purpose

The LPT ACC valve controls fan air flow to cool the LPT case.

Location

The LPT ACC valve is at the 3:00 position on the engine core. You must open the right T/R to get access to the LPT ACC valve.

Physical Description

The LPT ACC valve has solenoid control and pneumatic actuation. The valve has two positions: open or closed. The LPT ACC valve has these parts:

(1) Valve Position Indicator

(2) Lockout Control

(3) Servo air connection

(4) Solenoid

(5) Feedback switch.

The feedback switch sends valve position signal to the EEC. The feedback switch is an LRU.

Functional Description

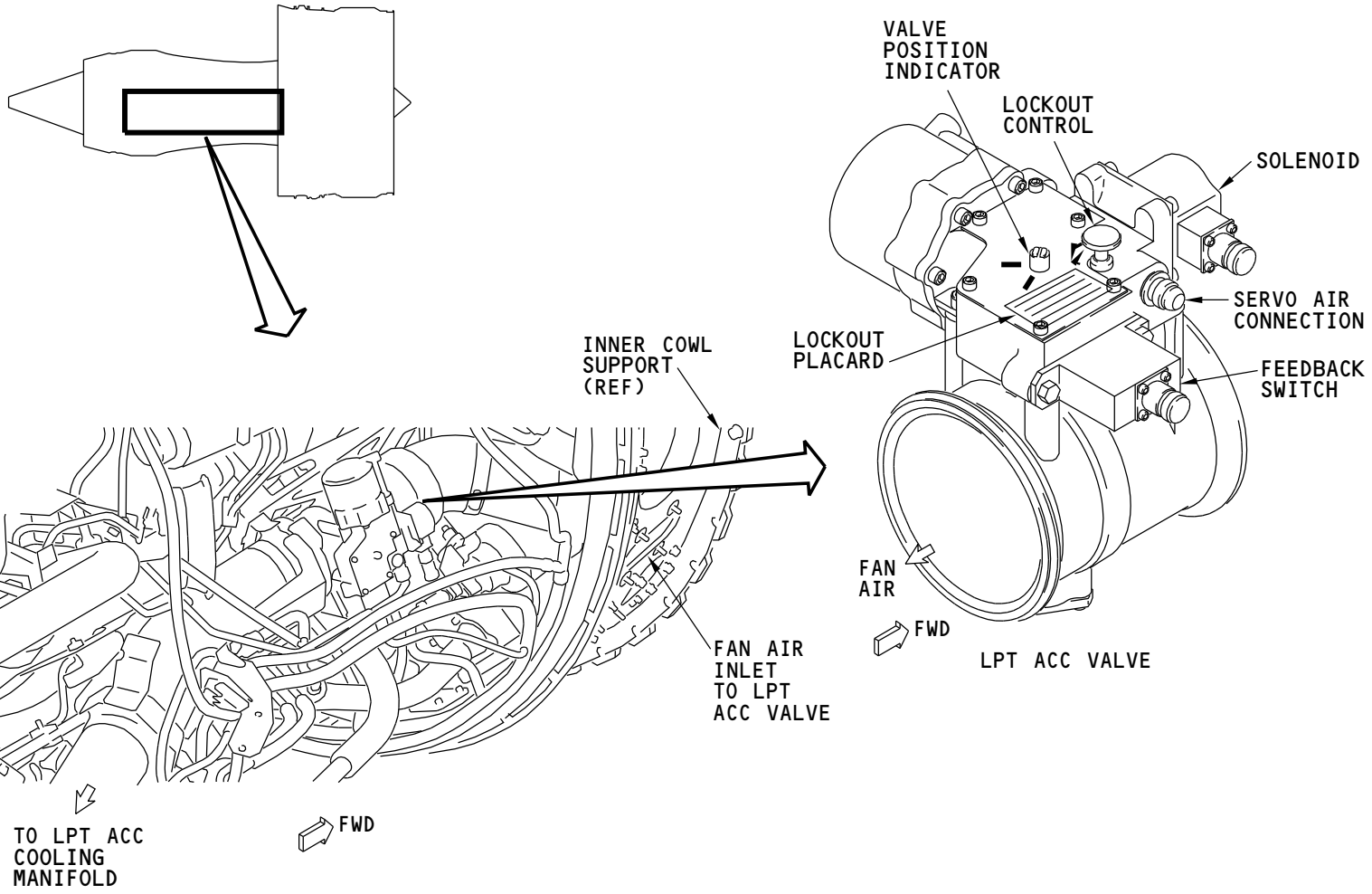
When the LPT ACC valve is open, full cooling flow goes to the LPT case. When the valve closes, a small amount of cooling flow goes to the LPT case.

The EEC controls the LPT ACC valve solenoid to move the valve. When the solenoid is not energized, a spring closes the valve. The valve is fail-safe to the closed position. When the solenoid energizes, seventh stage servo air moves the valve open.

Training Information Point

You can lock the LPT ACC valve closed. A placard on the valve tells you how to lock the valve. You use a tool in a slot in the valve position indicator to move the valve. You turn the lockout control on the valve to lock it closed.

The servo air line attaches to the actuator with a B-nut. Use the instruction for torque to tighten the B-nut (AMM 70-51-00/201).



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ENGINE AIR - TURBINE COOLING - LPT ACTIVE CLEARANCE CONTROL VALVE

ENGINE AIR - TURBINE COOLING - HPT ACTIVE CLEARANCE CONTROL VALVE

Purpose

The HPT ACC valve controls fan air flow to cool the HPT case.

Location

The HPT ACC valve is on the forward engine core at the 9:00 position. You must open the left T/R to get access to the HPT ACC valve.

Physical Description

The HPT ACC valve is a modulating valve. It uses servo fuel pressure for actuation. The HPT ACC valve has these parts:

- Valve position indicator
- Servo fuel connection (2)
- Drain can (2)
- Lockout pin
- LVDT.

Each servo fuel connection has a drain line and a drain can. The drain lines combine into one drain line that goes to the drain mast. The drain can collects fuel leakage. You do a check of the drain cans if you see a leak at the drain mast. This permits you to identify which connection has leakage. Observe the following caution:

CAUTION DO NOT REMOVE THE CAPTIVE BOLTS FROM THE DRAIN CAN. DAMAGE CAN OCCUR TO THE DRAIN CAN OR THE CAPTIVE BOLTS

An LVDT sends HPT ACC valve position to the EEC. It has two connections, one for each channel of the EEC.

Functional Description

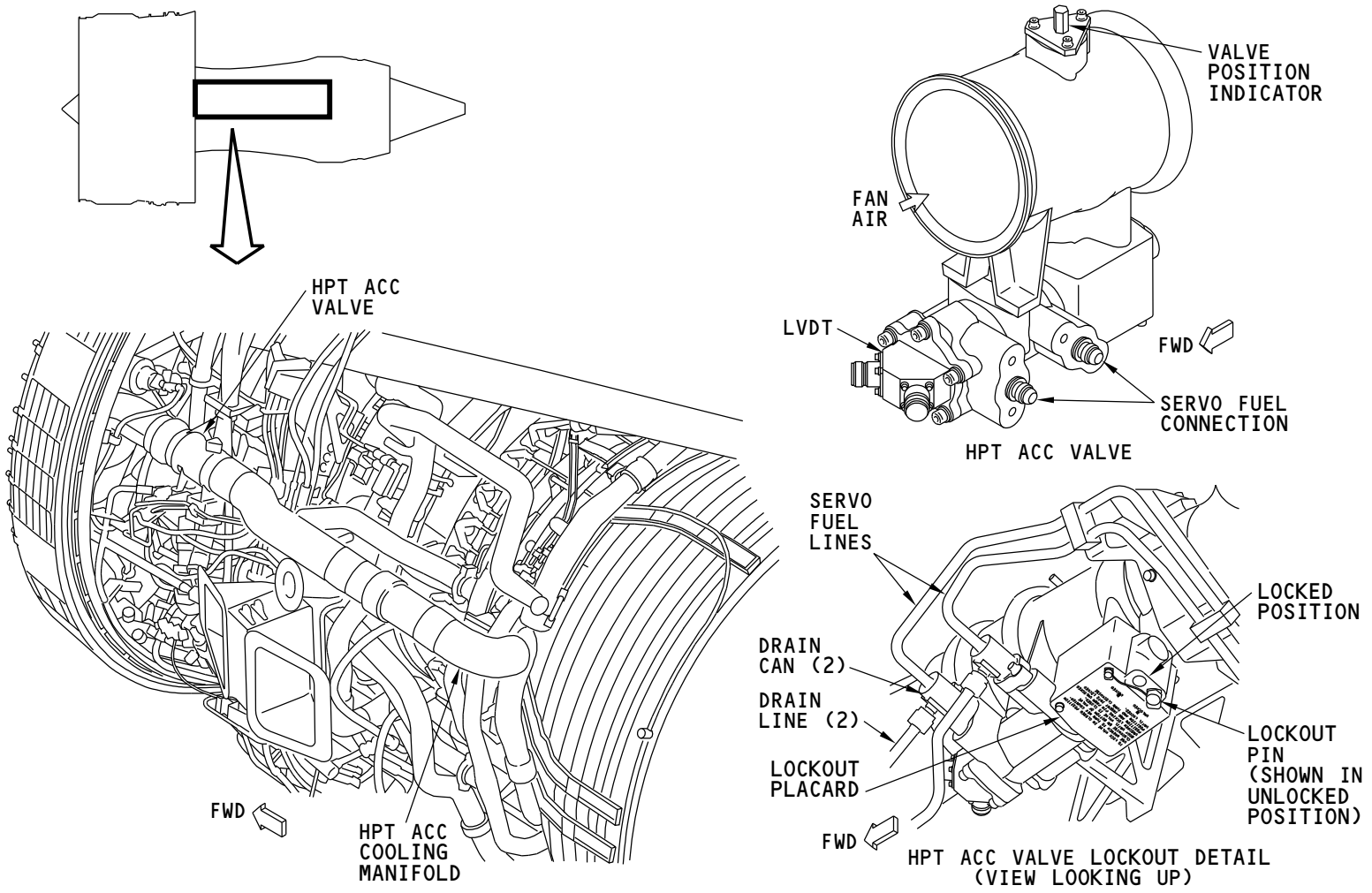
The EEC controls a torque motor in the HMU to control servo fuel pressure to the valve. There are two servo fuel lines to the valve. Pressure in one line moves the valve more open. Pressure in the other line moves the valve more closed.

Training Information Point

You can lock the HPT ACC valve closed. A placard on the valve tells you how to lock the valve. You put a tool on the hexagonal valve position indicator shaft to move the valve. You move the lockout pin from the UNLOCKED to the LOCKED position to keep the valve closed.

The servo fuel lines attach to the HPT ACC valve actuator with B-nuts. Observe this note when you tighten the B-nuts:

NOTE: Use the wrench arc method to tighten the B-nut (AMM 70-51-00/201).



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ENGINE AIR - TURBINE COOLING - HPT ACTIVE CLEARANCE CONTROL VALVE

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ENGINE AIR - VSV SYSTEM - GENERAL DESCRIPTION

General

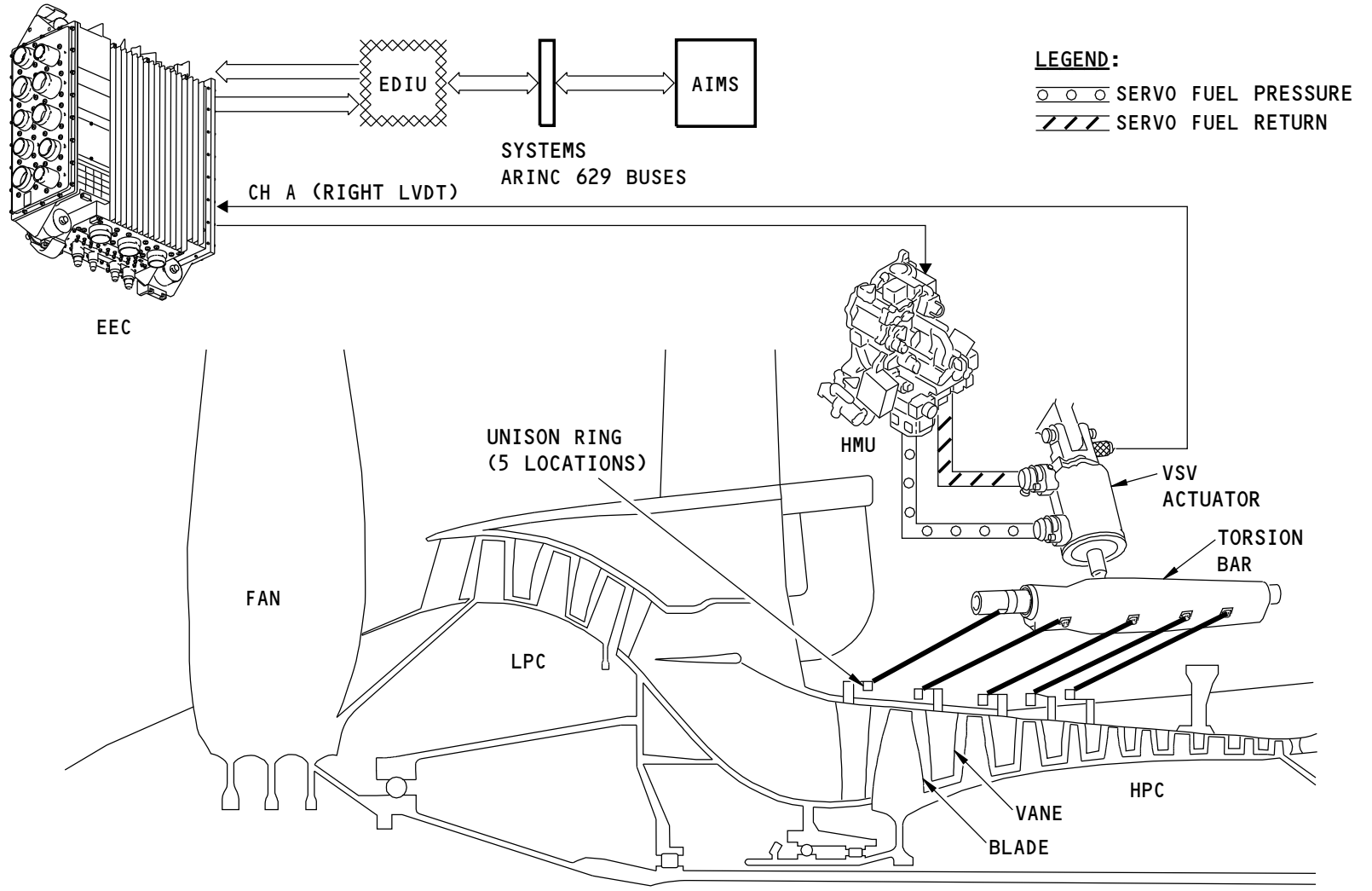
The VSV system moves the HPC Inlet Guide Vanes (IGV) and the 1st through 4th stage stator vanes to control the airflow through the HPC. The system automatically moves these vanes to the most efficient position at all power settings. There are two VSV actuators. One actuator is on the left side of the engine and one actuator is on the right side. You can find the VSV system faults on the MAT.

VSV Control

The EEC controls a torque motor in the HMU to operate the VSVs. The EEC uses N2 and T25 to control the torque motor. The torque motor sends fuel pressure to the VSV actuators to turn the torsion bars. The torsion bars move unison rings on the HPC. The unison rings connect to the stator vanes. When the unison rings move, the stator vane angles change.

Position Feedback

An LVDT in each actuator sends a position signal to the EEC. The left actuator LVDT sends a signal to EEC channel A. The right actuator LVDT sends a signal to EEC channel B. You can see VSV position on the EPCS maintenance page (not shown). The VSV position shows in percent open.



ENGINE AIR - VSV SYSTEM - GENERAL DESCRIPTION

ENGINE AIR - VSV SYSTEM - VSV ACTUATOR

Purpose

The VSV actuators move the variable stator vanes in the HPC.

Location

The VSV actuators are on the HPC case at the 2:30 and 8:30 positions. Each actuator attaches to the HPC case with a pin.

Physical Description

Each actuator has these parts:

- Servo fuel connection (2)
- Drain can (2)
- Actuator rod
- LVDT.

Each servo fuel connection has a drain line and a drain can. The drain lines combine into one drain line that goes to the drain mast. The drain can collects fuel leakage. You check the drain cans if you see a leak at the drain mast. This permits you to identify which connection has leakage. Observe the following caution:

CAUTION DO NOT REMOVE THE CAPTIVE BOLTS FROM THE DRAIN CAN. DAMAGE CAN OCCUR TO THE DRAIN CAN OR THE CAPTIVE BOLTS

The actuator has a rod that attaches to the torsion bar. When the actuator rod moves, the torsion bar turns.

A single channel LVDT in each actuator sends actuator position to one channel of the EEC. The left actuator LVDT connects to channel B and the right actuator connects to channel A.

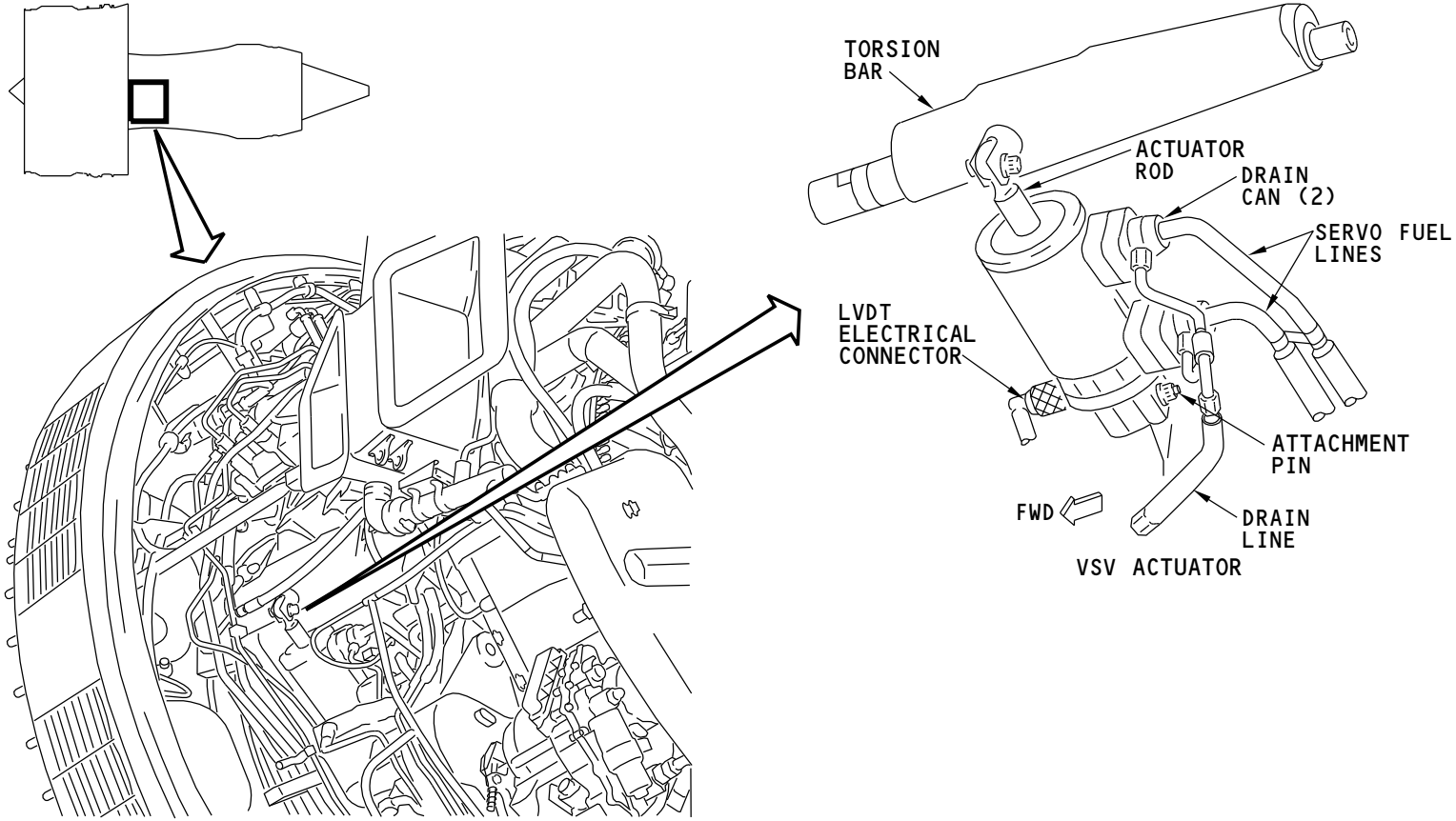
Functional Description

Servo fuel pressure moves each VSV actuator at the same time. Each actuator rod turns a torsion bar. The torsion bars attach to 5 unison rings (not shown). The unison rings attach to the HPC inlet guide vanes (IGV), and the 1st through 4th stage stator vanes. When the unison rings move, the IGVs and stator vanes move.

Training Information Point

The servo fuel lines attach to the VSV actuators with B-nuts. Observe this note when you tighten the VSV actuator B-nuts:

NOTE: Use the instruction for torque to tighten the B-nut (AMM 70-51-00/201).



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ENGINE AIR - VSV SYSTEM - VSV ACTUATOR

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ENGINE AIR - VBV SYSTEM - GENERAL DESCRIPTION

General

The VBVs open to let air go out of the engine core, through the VBV ducts, and into the fan stream. The VBV ducts open to the fan stream just aft of the LPC exit. This decreases the amount of air that goes into the HPC. The system operates automatically at all power settings. The VBVs move from full open at idle to full closed at takeoff. There are two VBV actuators and ten VBVs. One actuator is on the left side of the engine and one actuator is on the right side. You can find the VBV system faults on the MAT.

VBV Control

The EEC controls a torque motor in the HMU to operate the VBVs. These are the main inputs the EEC uses to control VBV operation:

(1) N1

(2) N2

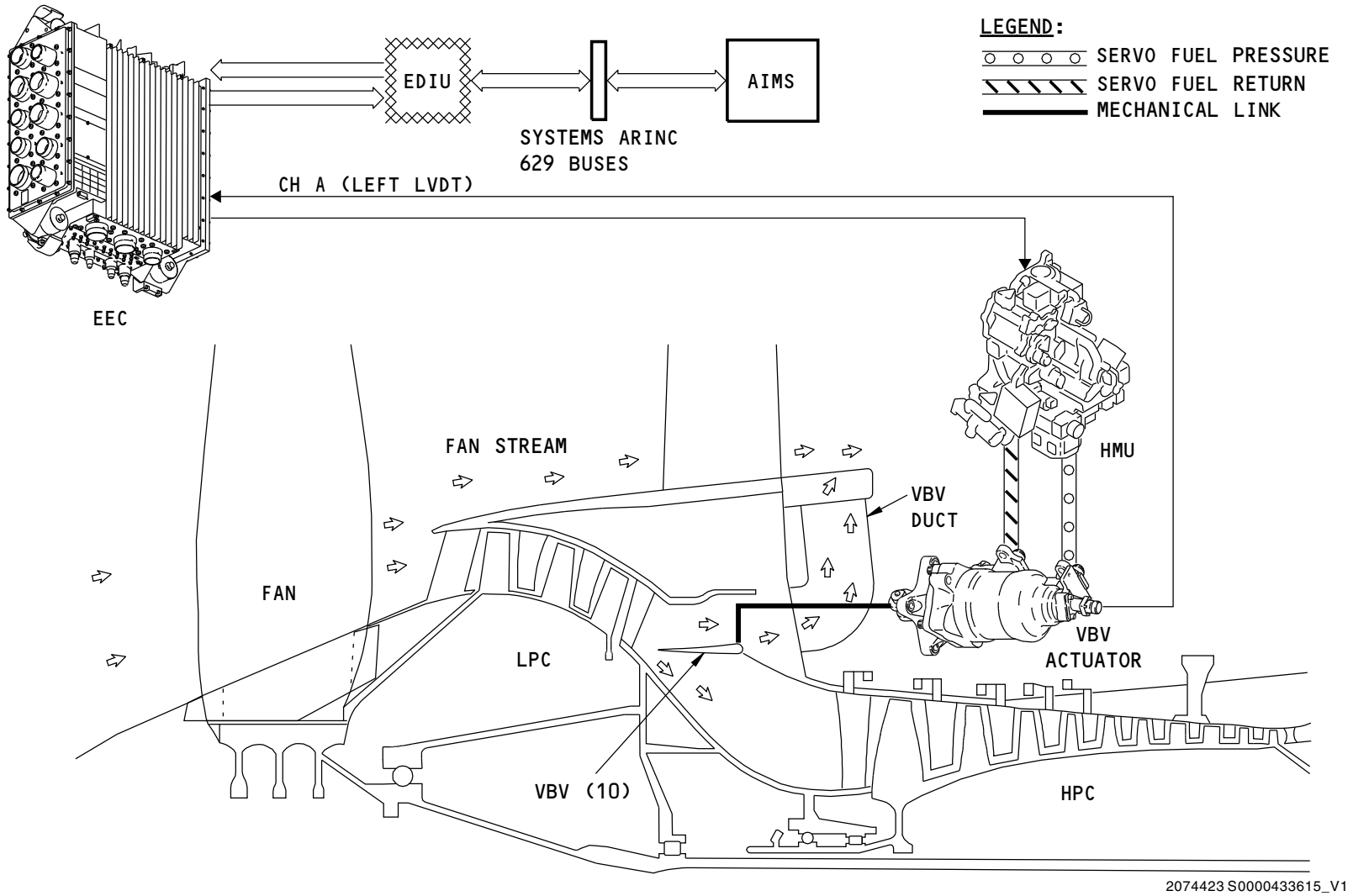
(3) T12

(4) T25.

The EEC sends a signal to a torque motor in the HMU. The torque motor sends fuel pressure to the VBV actuators to open or close the VBVs.

Position Feedback

An LVDT in each actuator sends a position signal to the EEC. The left actuator LVDT sends a signal to EEC channel A. The right actuator LVDT sends a signal to EEC channel B. You can see VBV position on the EPCS maintenance page. The VBV indication shows in percent open.



ENGINE AIR - VBV SYSTEM - GENERAL DESCRIPTION

ENGINE AIR - VBV SYSTEM - VBV ACTUATOR AND VBV

General

The VBV system has two actuators and ten valves. A unison ring and bellcrank linkages connect the actuators to the valves. The actuators turn the unison ring to move the VBVs.

Location

The actuators are on the forward engine core at the 3:30 and 9:30 positions. The VBV actuators attach to the fan hub frame with bolts.

The VBVs are forward of the actuators inside the fan hub frame. They are equally spaced around the engine.

VBV Actuators

Each actuator has these parts:

- Servo fuel connection (2)
- Drain can (not shown) (2)
- Rod
- LVDT.

Each servo fuel connection has a drain line (not shown) and a drain can. The drain lines combine into one drain line that goes to the drain mast. The drain can collects fuel leakage. You do a check of the drain cans if you see a leak at the drain mast. This permits you to identify which connection has leakage. Observe the following caution:

CAUTION DO NOT REMOVE THE CAPTIVE BOLTS FROM THE DRAIN CAN. DAMAGE CAN OCCUR TO THE DRAIN CAN OR THE CAPTIVE BOLTS

Each VBV actuator has a rod that attaches to one end of a bellcrank linkage. The other end of the bellcrank linkage attaches to the unison ring. When the actuator rod moves, the unison ring turns.

A single channel LVDT in each actuator sends actuator position to the EEC. The left actuator LVDT connects to channel A and the right LVDT connects to channel B.

Functional Description

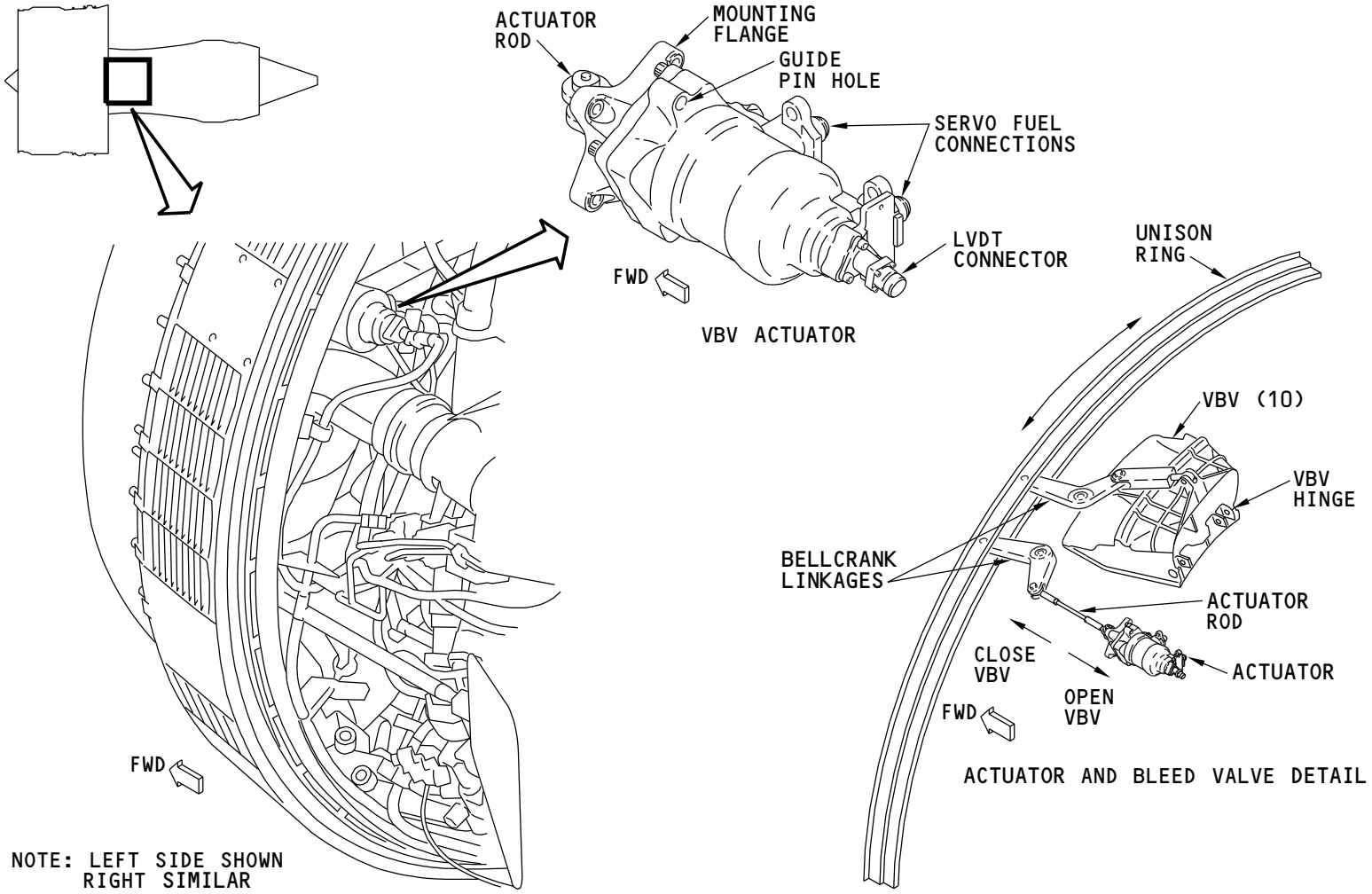
Servo fuel pressure moves the actuator rods forward and aft. The actuators move together to modulate the VBVs. When the rod moves forward, the unison ring turns clockwise. This causes the VBVs to move towards the closed position.

Training Information Point

You use a guide pin to install or remove the VBV actuator. The pin goes through a hole in the mounting flange and attaches to the fan hub frame. The pin supports and guides the actuator.

The servo fuel lines attach to the VBV actuators with B-nuts. Observe this note when you tighten the B-nuts:

NOTE: Use the instruction for torque to tighten the B-nut (AMM 70-51-00/201).



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ENGINE AIR - VBV SYSTEM - VBV ACTUATOR AND VBV