

CHAPTER

80

Engine Starting

(CFM56 ENGINES (CFM56-7))

CHAPTER 80
ENGINE STARTING

Subject/Page	Date	COC	Subject/Page	Date	COC
80-EFFECTIVE PAGES			80-00-00 (cont.)		
1	Jun 15/2016		17	Feb 15/2015	
2	BLANK		18	Feb 15/2015	
80-CONTENTS			19	Feb 15/2015	
1	Feb 15/2015		R 20	Jun 15/2016	
2	BLANK		R 21	Jun 15/2016	
80-00-00			22	Oct 15/2015	
1	Feb 15/2015		R 23	Jun 15/2016	
2	Feb 15/2015		R 24	Jun 15/2016	
3	Feb 15/2015				
4	Feb 15/2015				
5	Feb 15/2015				
6	Feb 15/2015				
7	Feb 15/2015				
R 8	Jun 15/2016				
9	Feb 15/2015				
10	Feb 15/2015				
11	Feb 15/2015				
12	Feb 15/2015				
13	Feb 15/2015				
14	Feb 15/2015				
R 15	Jun 15/2016				
R 16	Jun 15/2016				

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**CHAPTER 80
ENGINE STARTING**

<u>CH-SC-SU</u>	<u>SUBJECT</u>	<u>PAGE</u>	<u>EFFECT</u>
80-00-00	ENGINE STARTING - INTRODUCTION	2	AKS ALL
80-00-00	ENGINE STARTING - GENERAL DESCRIPTION	4	AKS ALL
80-00-00	ENGINE STARTING - COMPONENT LOCATIONS - ENGINE	6	AKS ALL
80-00-00	ENGINE STARTING - COMPONENT LOCATIONS - FLIGHT COMPARTMENT AND EE COMPARTMENT	8	AKS ALL
80-00-00	ENGINE STARTING - START VALVE	10	AKS ALL
80-00-00	ENGINE STARTING - STARTER	12	AKS ALL
80-00-00	ENGINE STARTING - FUNCTIONAL DESCRIPTION	15	AKS ALL
80-00-00	ENGINE STARTING - TRAINING INFORMATION POINT	18	AKS ALL
80-00-00	ENGINE STARTING - OPERATION	20	AKS ALL

80-CONTENTS

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**ENGINE STARTING - INTRODUCTION****General**

The engine starting system uses pneumatic power to turn the engine's N2 rotor during a start or motor procedure. Pneumatic power comes from one of these sources:

- APU
- Pneumatic ground equipment
- Opposite engine.

These components control the engine start system:

- Flight compartment switches
- Display electronics unit (DEU)
- Electronic engine control (EEC).

The engine starting system operates on the ground and in flight.

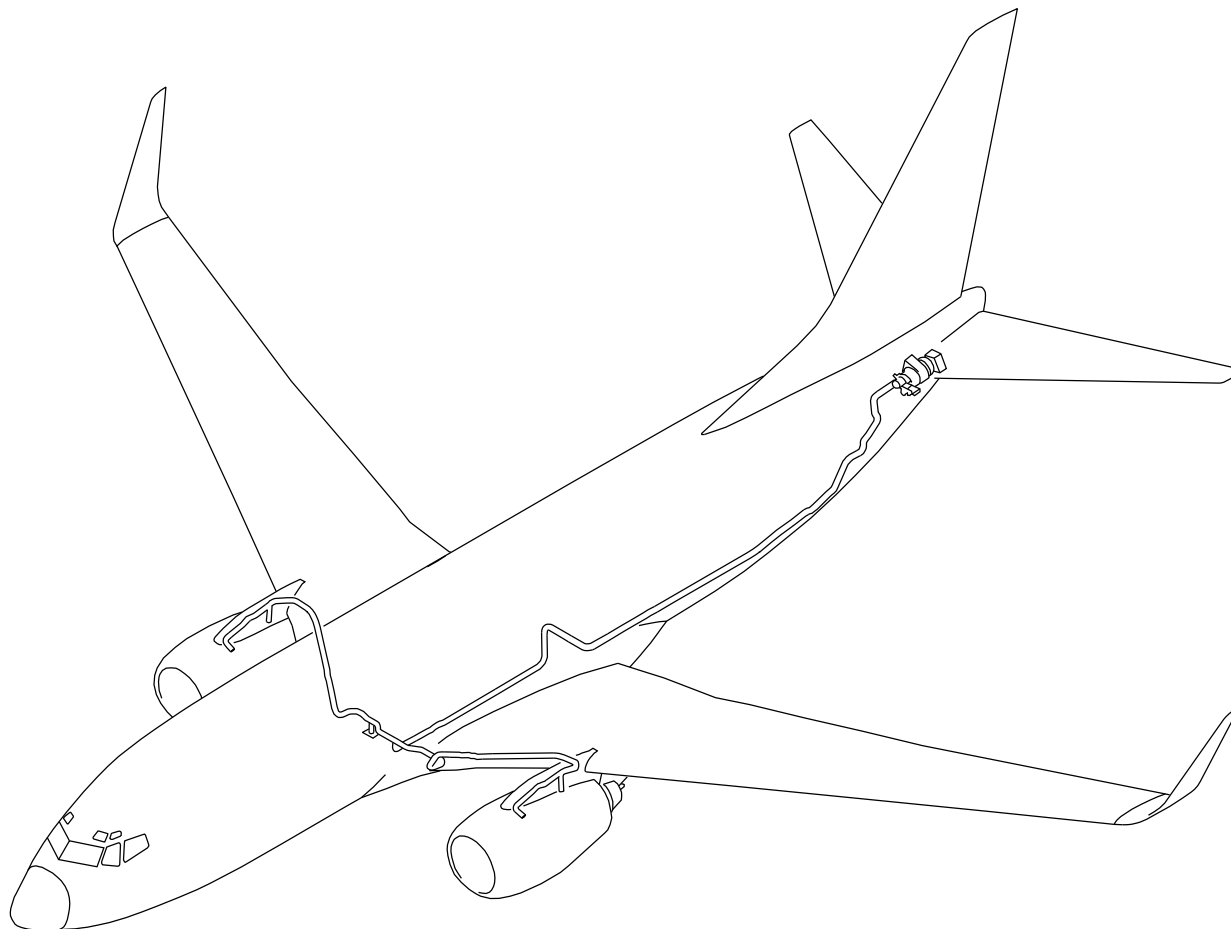
Abbreviations & Acronyms

- AGB - engine accessory gearbox
- ALF - aft looking forward
- AMM - airplane maintenance manual
- CDS - common display system
- CDU - control display unit
- DEU - display electronics unit
- EEC - electronic engine control
- FMCS - flight management computer system

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ENGINE STARTING - INTRODUCTION

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**ENGINE STARTING - GENERAL DESCRIPTION****General**

The engine starting system uses these airplane and engine systems or components:

- Pneumatic power
- Electrical power
- Flight compartment switches
- Engine fuel control system
- Engine control system.
- Common display system (CDS).

Engine Start Switch

You put the engine start switch to the GRD position to turn the engine with the starter. The switch automatically moves to the OFF position at starter cutout.

When electrical and pneumatic power is available, this happens when you put the switch to the GRD position:

- Electronic engine control (EEC) receives a start signal
- APU receives an engine start signal
- Start valve opens and the pneumatic starter turns the engine.

The crew uses the FLT position to start the engine in flight when the starter is not necessary.

The CONT position supplies continuous ignition.

See the engine ignition chapter for more information on the ignition system. (CHAPTER 74)

Start Valve and Starter

The start valve opens to supply power to the starter. Usually, this valve opens when you put the engine start switch to the GRD position. The start valve position shows on the engine display. You can manually open the valve.

The starter turns the engine N2 rotor through the engine accessory gearbox (AGB).

EEC

The EEC protects the engine during start. The EEC shuts off fuel supply to the engine when it finds the engine parameters are out of limits during a start.

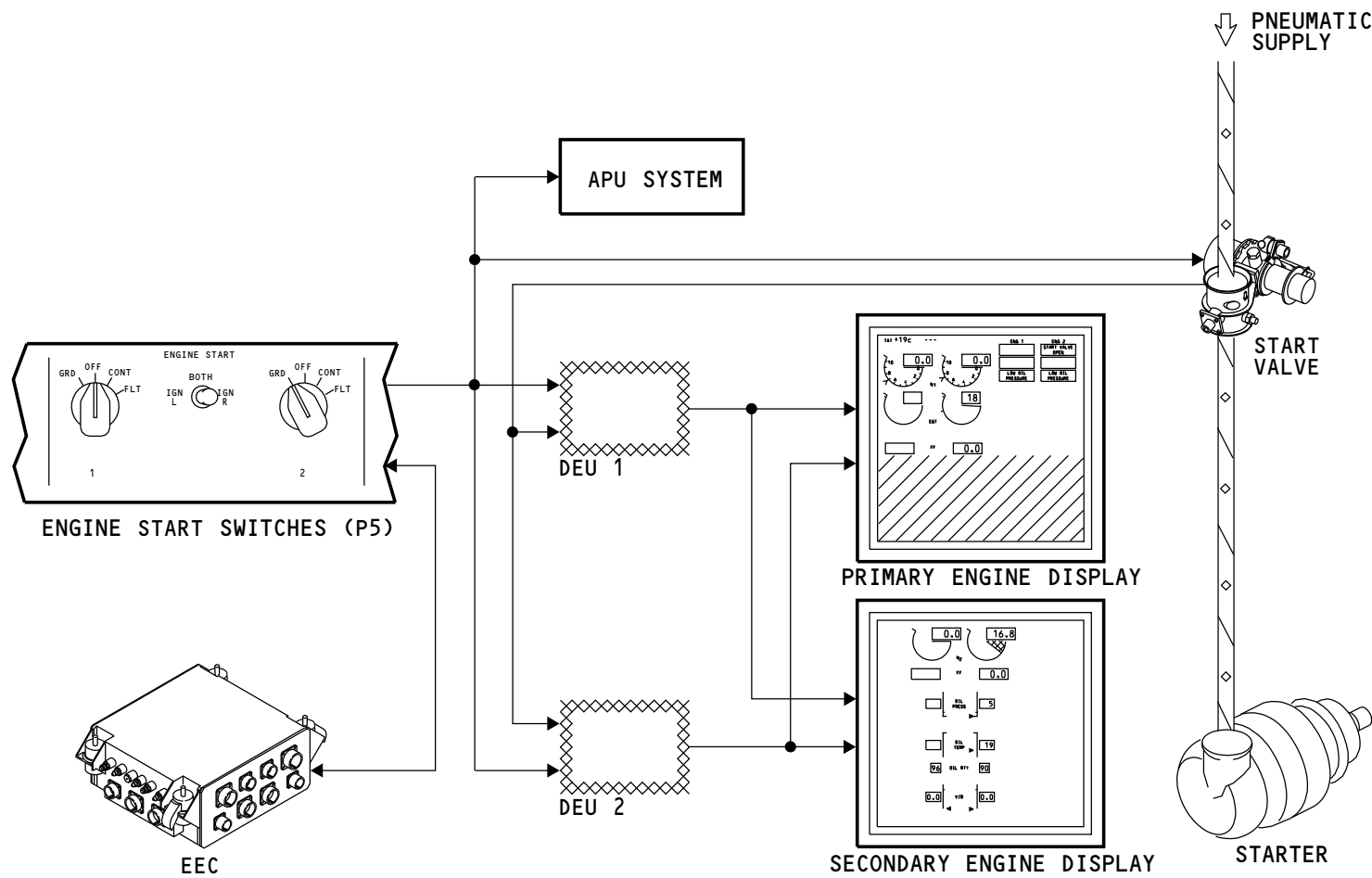
Display Electronics Units (DEUs)

The DEUs are components of the common display system (CDS). The DEUs monitor N2 and let the engine start switch go back to the OFF position at starter cutout.

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ENGINE STARTING - GENERAL DESCRIPTION

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**ENGINE STARTING - COMPONENT LOCATIONS - ENGINE****General**

The engine starting system has these components on the left side of the engine:

- Pneumatic starter ducts
- Start valve
- Starter.

You open the left fan cowl to get access to these components.

The electronic engine control (EEC) is on the right side of the engine fan case at the 2:00 position, aft looking forward (ALF). You open the right fan cowl to get access to the EEC.

Pneumatic Starter Ducts

There are two pneumatic starter duct assemblies.

The upper assembly has two tubes and two flexible joints. One end connects to a pneumatic duct at the strut. The other end attaches to the start valve. The assembly attaches to the fan case.

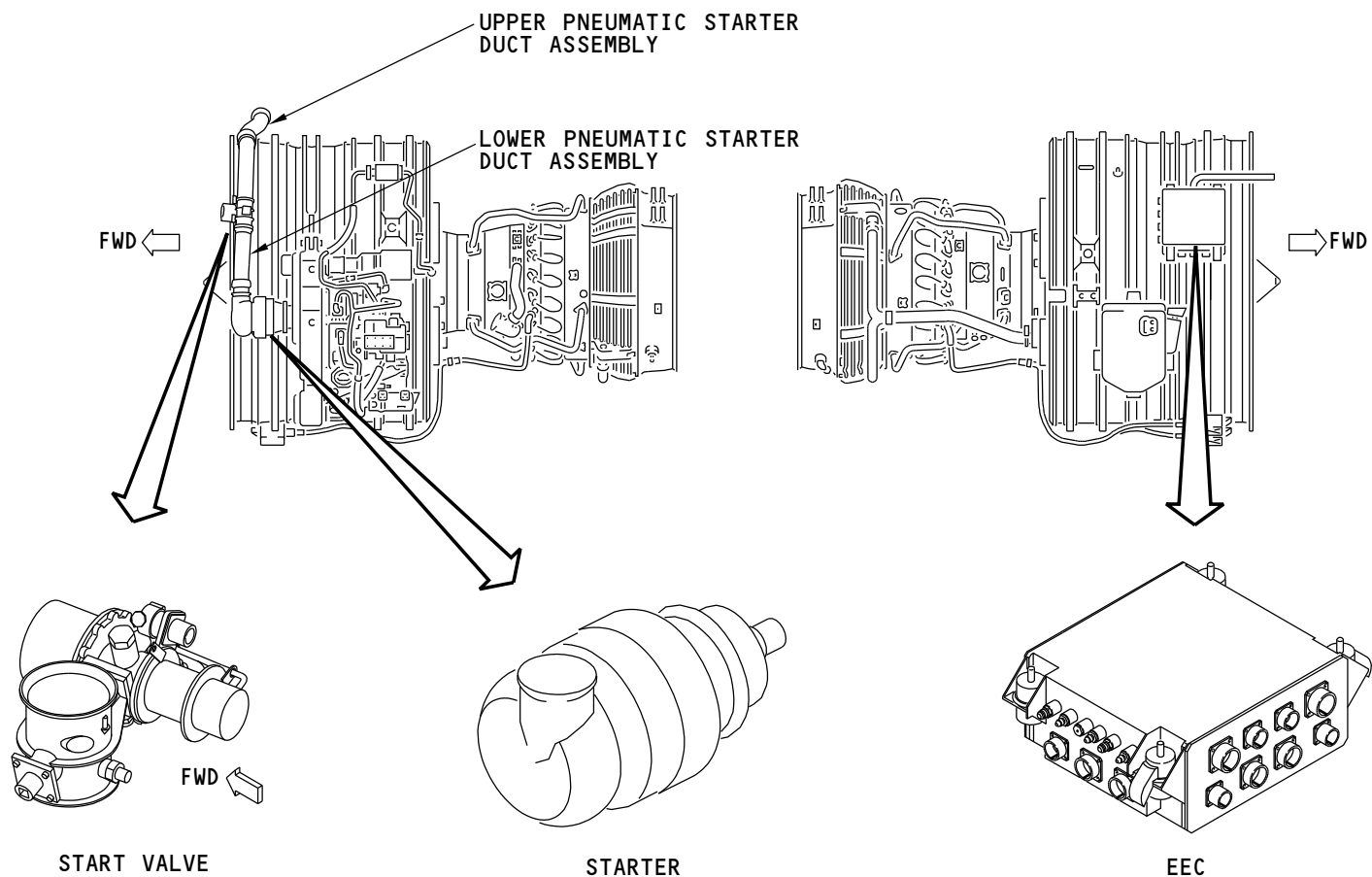
The lower assembly has one tube. The assembly connects to the start valve and to the starter. The assembly attaches to the fan case.

Start Valve

The start valve is above the starter on the fan case.

Starter

The starter is on the forward face of the engine accessory gearbox (AGB) at the 8:00 position.



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ENGINE STARTING - COMPONENT LOCATIONS - ENGINE

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**ENGINE STARTING - COMPONENT LOCATIONS - FLIGHT COMPARTMENT AND EE COMPARTMENT****Flight Compartment**

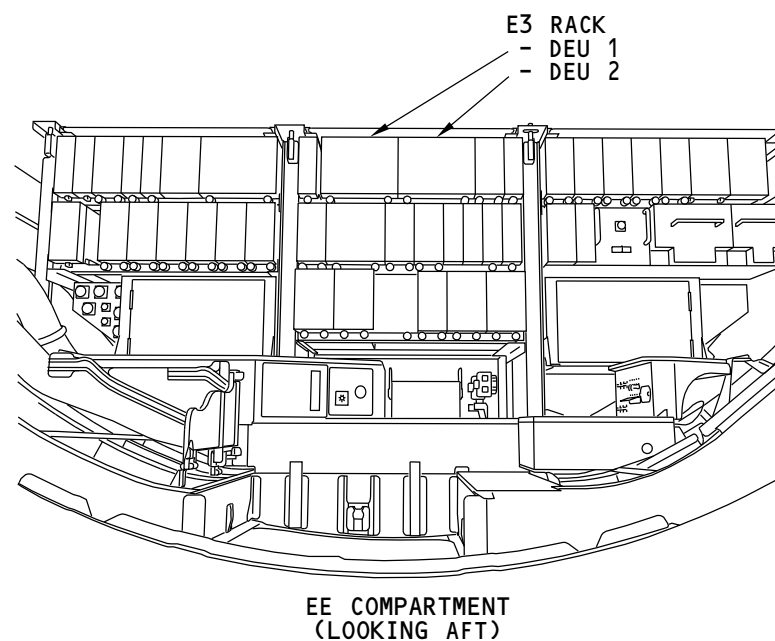
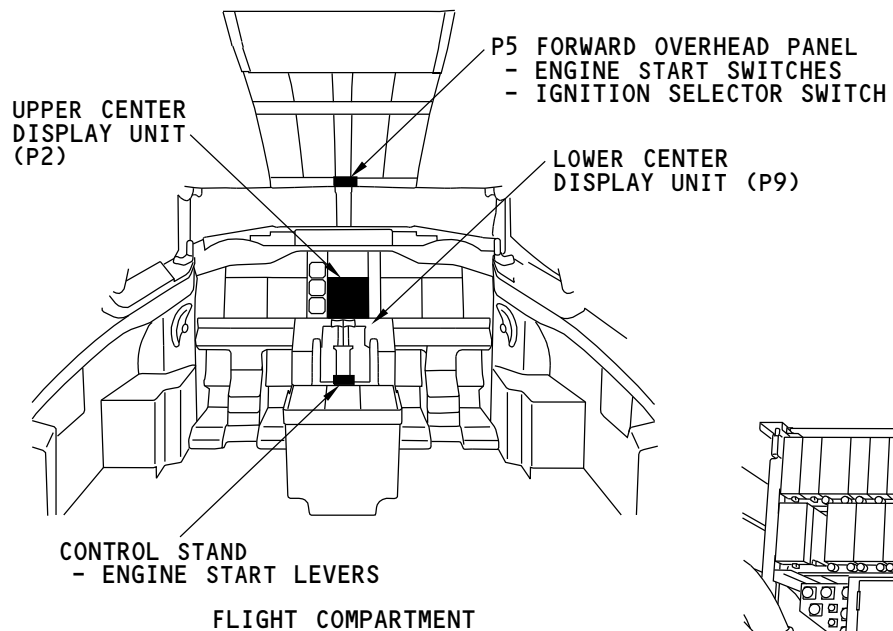
The engine start switches and the ignition selector switch are on the P5 forward overhead panel.

The upper center display unit is on the P2 main panel center. The engine parameters usually show on this display. The parameters can also show on the lower center display unit.

| The engine start levers are on the control stand, aft of the thrust levers.

Electrical Equipment Compartment

The display electronics units (DEU)s are on the E3 rack.



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ENGINE STARTING - COMPONENT LOCATIONS - FLIGHT COMPARTMENT AND EE COMPARTMENT

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**ENGINE STARTING - START VALVE****Purpose**

The start valve controls pneumatic power to the starter. The valve opens for these engine operations:

- Ground start
- In flight starts which require starter assist
- Motoring.

Physical Description

The valve is a butterfly shutoff valve. It is electrically controlled and pneumatically operated. The valve is spring-loaded closed.

The primary components are the valve body assembly and the actuator assembly.

The valve body assembly has these components:

- Butterfly valve
- Valve shaft
- Shaft bearings
- External position indicator.

The actuator assembly has these components:

- Torsion spring
- Pneumatic actuator
- Solenoid valve assembly
- Valve position switch
- Manual override provision.

Functional Description

The valve solenoid energizes when you put the engine start switch to the GRD position. This permits air pressure to the pneumatic actuator. The pneumatic actuator force is more than the torsion spring force and the start valve opens.

The DEUs use the valve position switch to supply indication in the flight compartment.

You use a 3/8 inch square drive tool to manually open the valve. A visual indicator on the valve body shows valve position.

A small hole in the left fan cowl gives you access to the manual override. A placard is near the hole.

Training Information Point

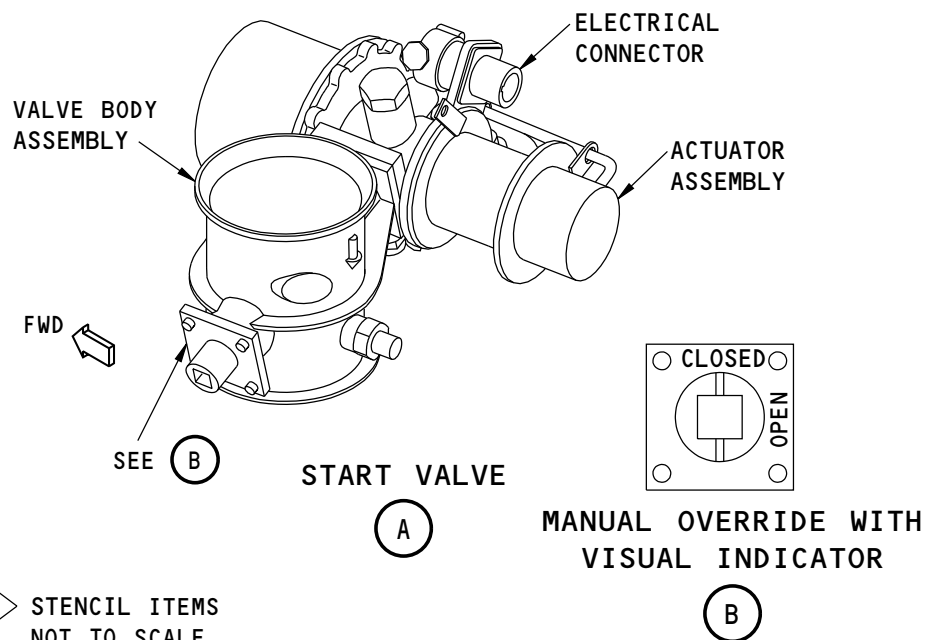
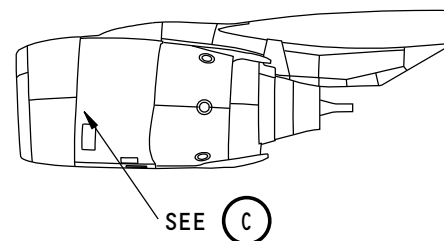
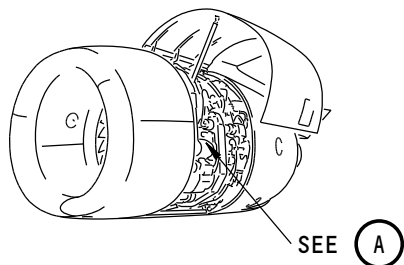
WARNING: REMOVE PNEUMATIC POWER FROM THE AIRPLANE BEFORE YOU REMOVE THE START VALVE. AIR PRESSURE IN THE PNEUMATIC STARTER DUCT COULD CAUSE INJURY.

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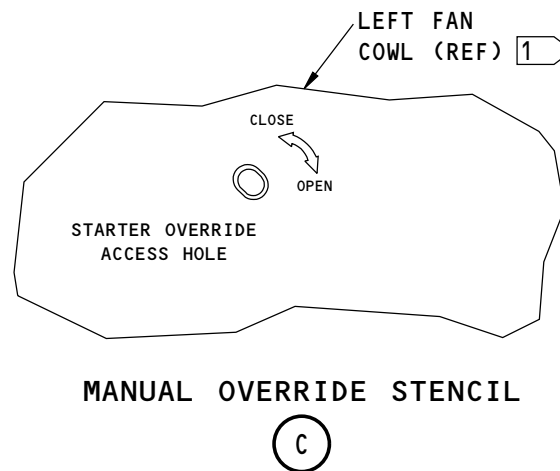
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ENGINE STARTING - START VALVE

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ENGINE STARTING - STARTER

Purpose

The starter turns the engine for engine starting or motoring procedures. The starter changes air pressure into mechanical energy.

Physical Description

The starter has a single-stage, axial-flow, turbine air motor. The starter uses reduction gears and a sprag clutch to turn the output shaft to the engine accessory gearbox (AGB).

The starter has one port for oil drain and fill. This port also has a magnetic chip detector.

A coupling attaches the starter to the AGB. A coupling attaches the lower pneumatic starter air duct assembly to the top of the starter.

Functional Description

Pneumatic power goes through an open start valve to turn the turbine air motor in the starter. The turbine turns the reduction gears and engages the clutch. The clutch transmits torque to the output shaft of the starter. The reduction gears engage the clutch as long as pneumatic power turns the turbine.

The starter output shaft turns the AGB. The AGB turns the engine N2 rotor through shafts and other gears.

At approximately 55 percent N2, the start valve closes and removes pneumatic power from the starter. The turbine and reduction gears slow and the clutch disengages. The starter output shaft then turns with the gearbox and engine. The turbine and reduction gears continue to slow until they stop.

The starter receives a continuous flow of oil from the AGB when the engine turns. The oil cools and lubricates the starter:

- Clutch
- Gears
- Bearings.

Oil returns to the AGB. A small quantity of oil stays in the starter.

Training Information Point

It is not necessary to add oil to the starter after installation. But, you must supply a new starter with a small quantity of oil. Refer to chapter 12 of the airplane maintenance manual (AMM) part II for oil quantity requirements and procedures.

After installation, the AGB maintains the starter oil level.

WARNING: DO NOT LET ENGINE OIL STAY ON YOUR SKIN. FLUSH THE OIL FROM YOUR SKIN WITH WATER. THE OIL IS POISONOUS.

CAUTION: DO NOT HANG THE STARTER BY THE DRIVE SHAFT. INTERNAL STARTER DAMAGE CAN OCCUR.

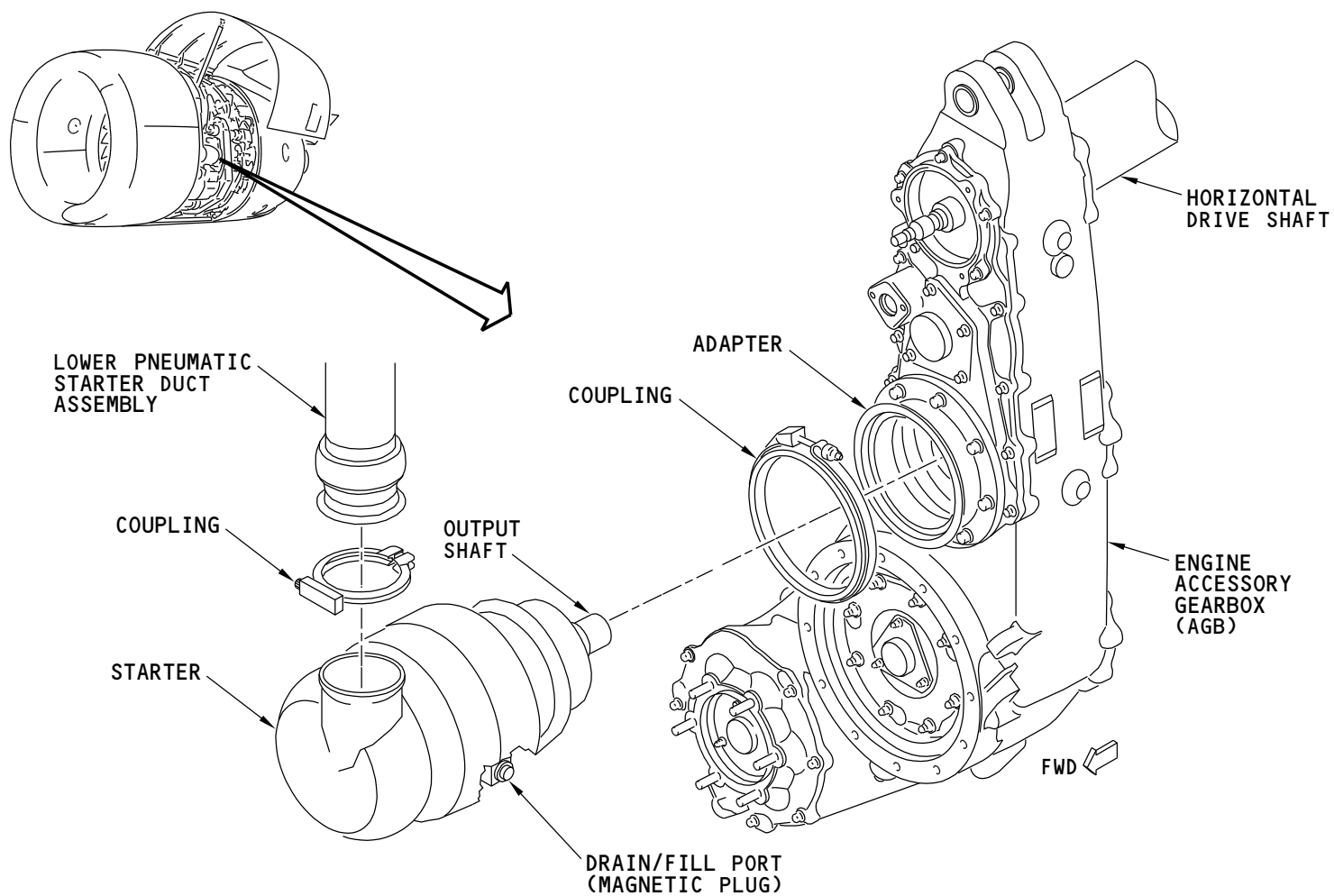
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ENGINE STARTING - STARTER

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ENGINE STARTING - FUNCTIONAL DESCRIPTION

Starting Control

Electrical power for engine starting control comes from the battery bus. The engine start switch and the DEUs control the starting system.

Indication

The DEUs use input data to show engine parameters and start valve position on the common display system (CDS).

These are the two modes of operation for the amber START VALVE OPEN message:

- Steady
- Flash (crew alert).

The START VALVE OPEN message is steady when the start valve is open and the start switch is in the ground position.

The START VALVE OPEN message flashes for 10 seconds then shows steady when the start valve is open and the start switch is not in the ground position.

All three crew alert boxes flash for 10 seconds and the applicable alert message then shows continuously.

Start Switch

These occur when you put the engine start switch to the GRD position when electrical and pneumatic power are available:

- EEC receives an engine start signal
- APU electronic control unit receives a signal to open the APU inlet guide vanes
- Start valve solenoid energizes and the valve opens
- Starter clutch engages and the engine N2 rotor turns
- Solenoid in the P5 panel energizes to hold the switch in the GRD position.

Fuel and Ignition

You move the engine start lever to the IDLE or RUN position to add fuel and ignition during the start.

See the engine fuel and control chapter for more information. (CHAPTER 73) See the ignition chapter for more information. (CHAPTER 74)

Starter Cutout

At 55 percent N2, this occurs:

- DEUs remove the electrical ground for the start switch solenoid
- Engine start switch goes to the OFF position
- Start valve solenoid deenergizes and the valve closes.

Engine Wet Start

The EEC stops the engine start if the EGT does not increase in 15 seconds after you move the engine start lever to the idle position. The EEC stops fuel flow and turns off ignition. You can find a fault message on the control display unit (CDU). See the TRAINING INFORMATION POINT page in this section for more information.

The EEC stops the engine start if the EGT does not increase in 15 seconds after you move the fuel control switch to the run position. The EEC stops fuel flow and turns off ignition. You can find a fault message on the control display unit (CDU). See the TRAINING INFORMATION POINT page in this section for more information.

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**ENGINE STARTING - FUNCTIONAL DESCRIPTION****Engine Hot Start**

The EGT digital display flashes when the EEC finds there is a possible hot start. If the EGT starting limit is exceeded, the EEC stops fuel flow and ignition. The EGT digital display continues to flash until you move the engine start lever to the CUTOFF position. This system operates on the ground only.

NOTE: If you operate engines, you should know normal engine starting parameters. You should also know the maximum and minimum limits for each parameter. You should stop a hot engine start before the EEC does.

In-Flight Start

The crew puts the engine start switch to the FLT position for a windmill start. A windmill start does not use the starter.

The crew uses the starter in flight if the airplane is out of windmill start limits. See the flight operation manual for more information about these limits. The CDS tells the crew that the airplane is out of limits to windmill start the engine. The message X-BLEED START shows above the N2 digital indicator. For this condition, the flight crew uses the starter to start the engine. The OPERATION page in this section shows this message on the display.

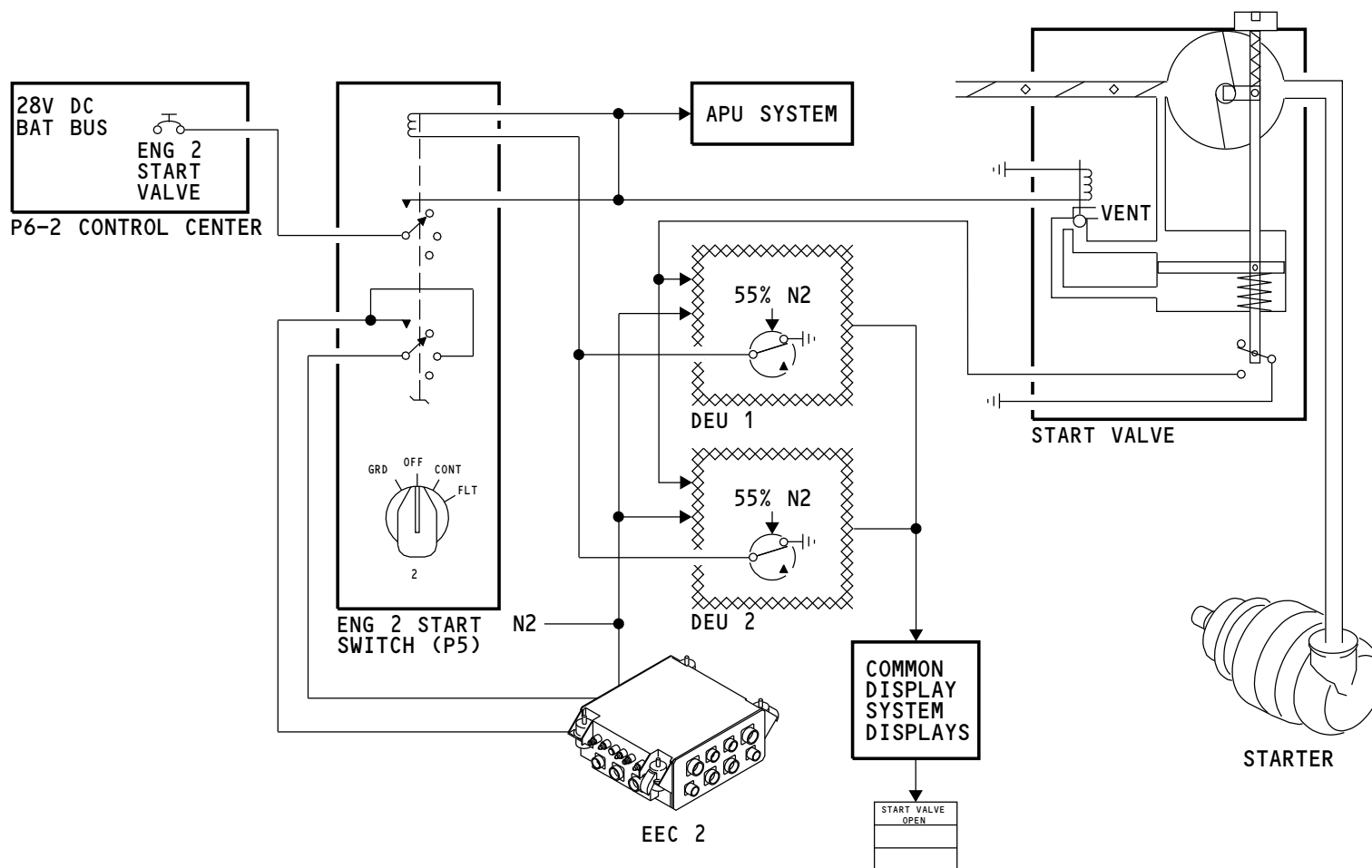
Automatic Ignition

The EEC can automatically start ignition. See the engine ignition chapter for more information. (CHAPTER 74)

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ENGINE STARTING - FUNCTIONAL DESCRIPTION

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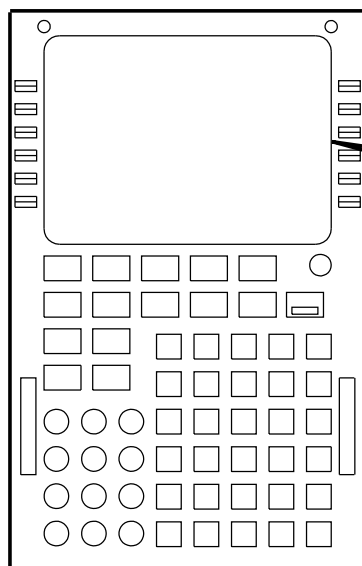
ENGINE STARTING - TRAINING INFORMATION POINT

General

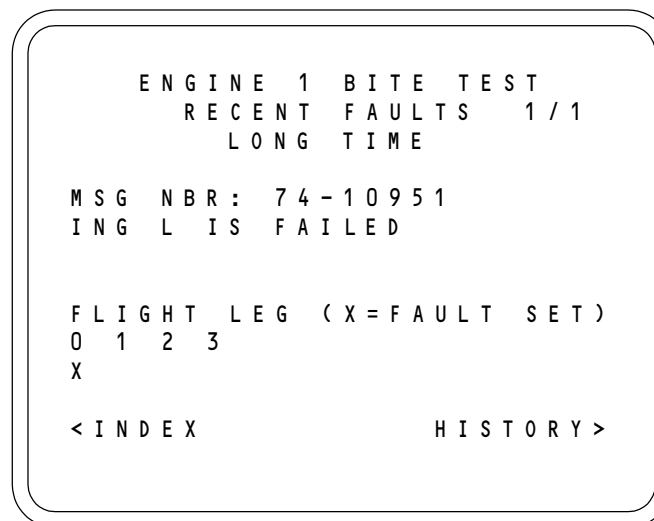
You can use the control display units (CDUs) to troubleshoot problems when the engine does not start.

The EEC keeps maintenance messages in its non-volatile memory. The EEC keeps a message during an engine start if the EGT does not increase in 15 seconds after you move the start lever to the idle position. You use the CDU to see this message.

See the engine indicating chapter for more information about engine troubleshooting with the CDU. (CHAPTER 77)



CDU



ENGINE STARTING - TRAINING INFORMATION POINT

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**ENGINE STARTING - OPERATION****General**

These are the flight compartment controls you use to start the engine:

- Engine start switches
- Ignition select switch
- Engine start levers.

Pneumatic power must be available to start the engine on the ground.

You must monitor these engine parameters during engine starting:

- N2
- Oil pressure
- N1
- Fuel flow
- EGT.

Engine Start

This is a summary of the engine start procedure:

- Follow safety procedures and airplane and engine limitations
- Set the ignition select switch to IGN L or IGN R
- Put the engine start switch to the GRD position
- Look for start valve open indication
- Monitor N2
- Make sure oil pressure increases
- Speak with ground personnel to make sure N1 begins to turn counterclockwise
- Move the engine start lever to the IDLE or RUN position (forward) at a minimum of 25 percent N2
- Make sure fuel flow is in limits
- Make sure EGT increases
- Monitor EGT and N2 increase until starter cutout at 55 percent N2

- Make sure engine start switch goes back to the OFF position at 55 percent N2
- Monitor all engine parameters as engine speed increases to idle.

Training Information Point

Usually, only one igniter is necessary for starting. You should use a different igniter selection for each start.

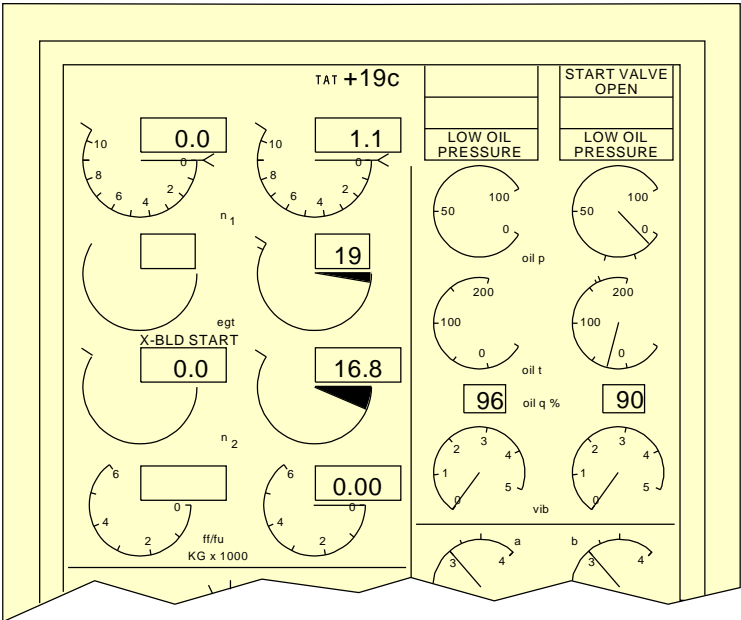
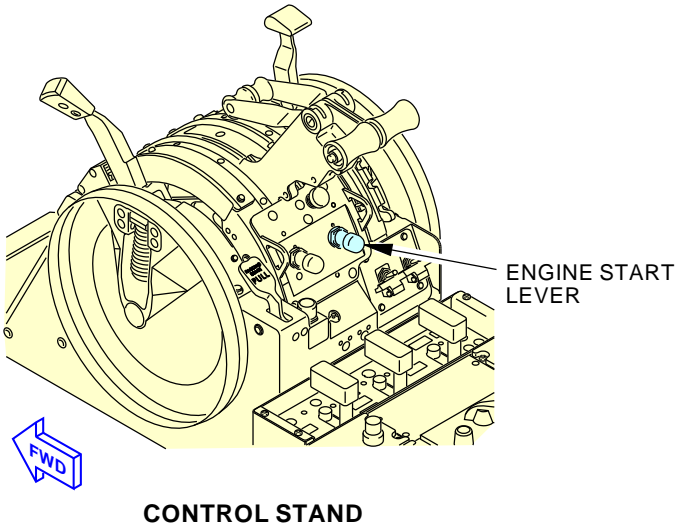
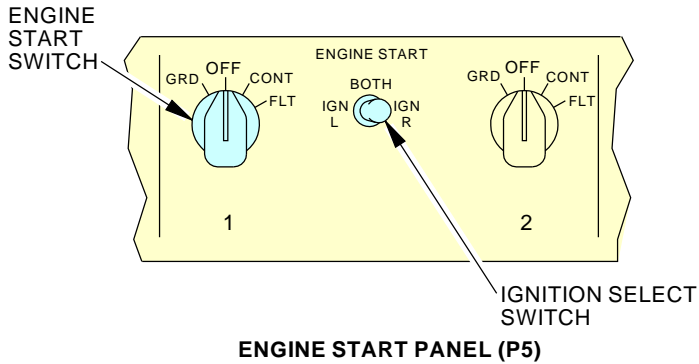
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ENGINE STARTING - OPERATION

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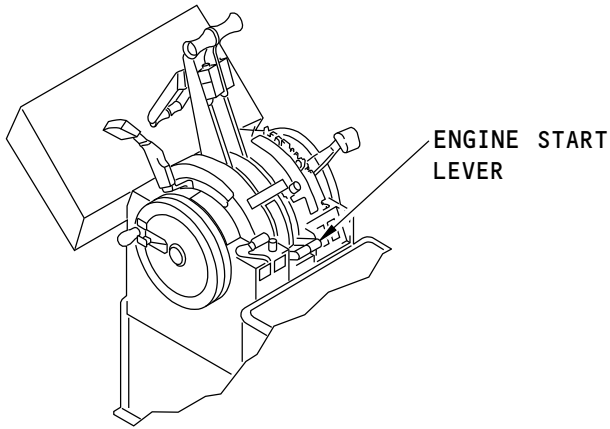
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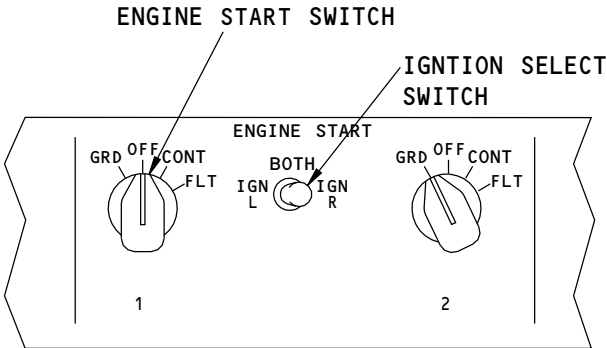
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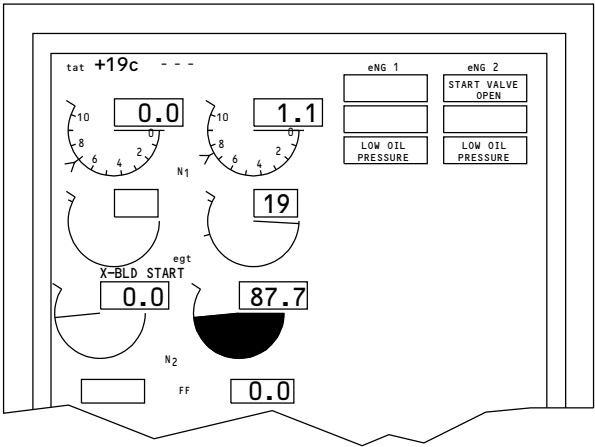
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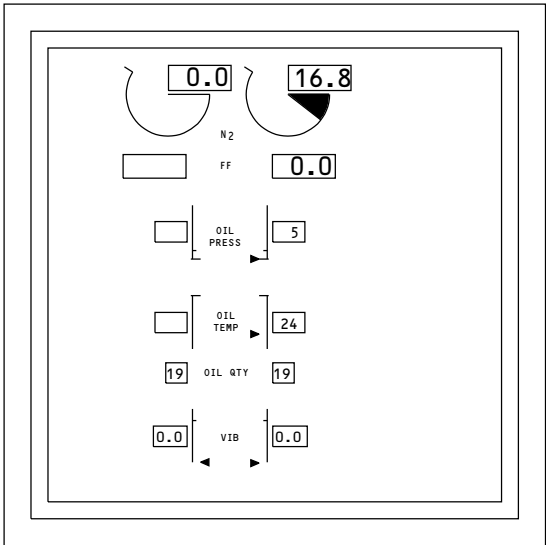
CONTROL STAND



ENGINE START PANEL (P5)



PRIMARY ENGINE DISPLAY



SECONDARY ENGINE DISPLAY

ENGINE STARTING - OPERATION

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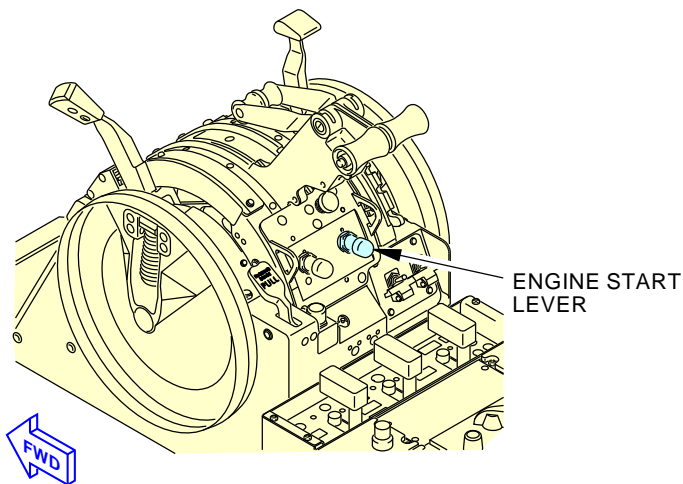
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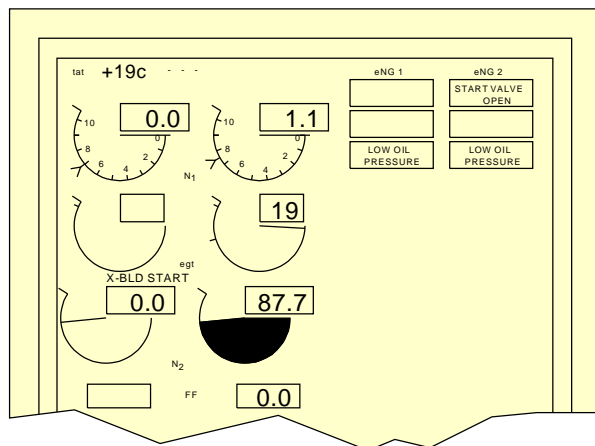
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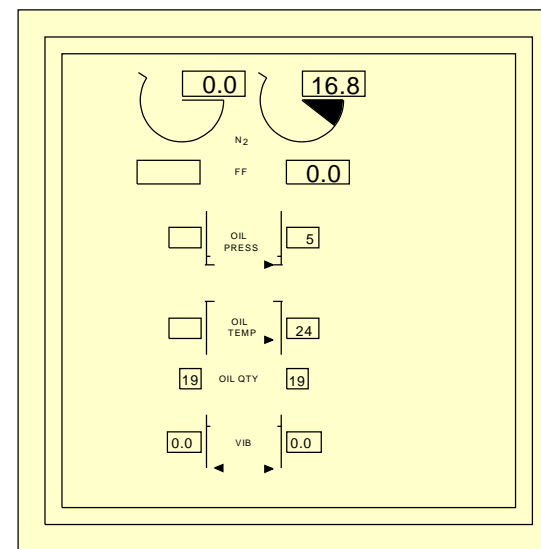
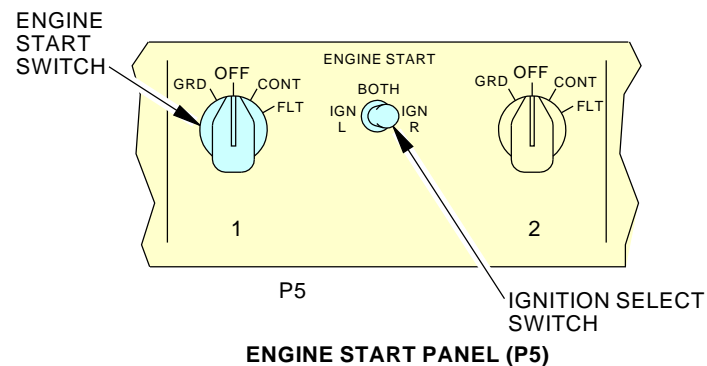
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CONTROL STAND



PRIMARY ENGINE DISPLAY



SECONDARY ENGINE DISPLAY

ENGINE STARTING - OPERATION

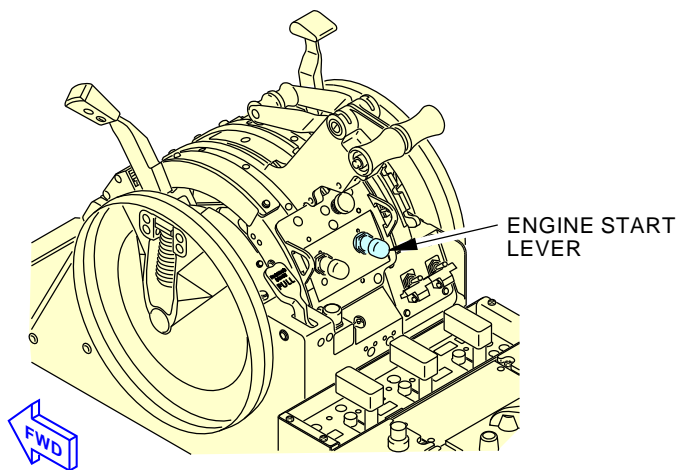
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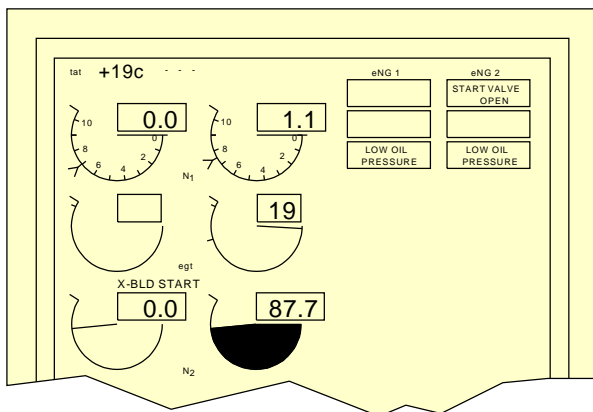
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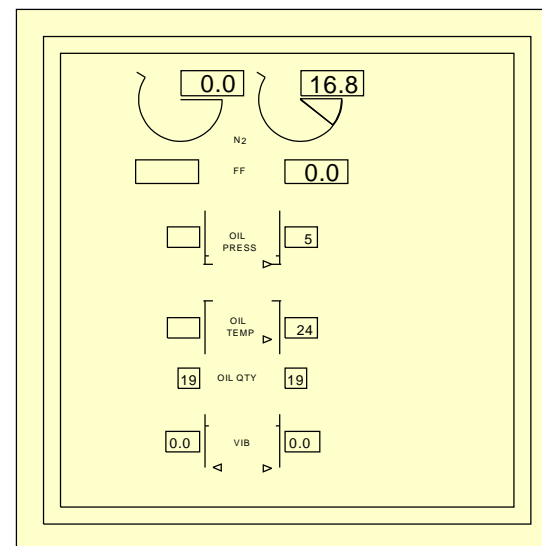
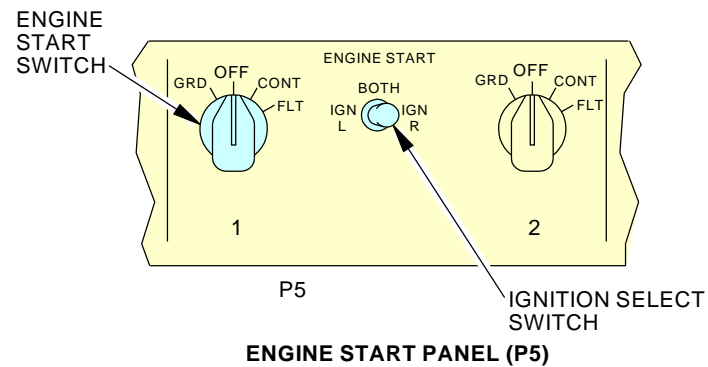
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CONTROL STAND



PRIMARY ENGINE DISPLAY



SECONDARY ENGINE DISPLAY

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