BOEING 737
NEXT GENERATION

MALEV VIRTUAL

Topics

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- Overview
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- System schematic
- Normal operations
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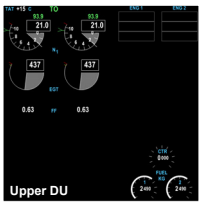
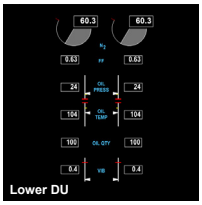
Engines
Specifications

The airplane is powered by two **CFM56–7** engines. The engine is a dual–rotor, axial–flow turbofan. The **N1** rotor consists of a **fan**, a **low–pressure compressor** and a **low–pressure turbine**. The **N2** rotor consists of a **high–pressure compressor** and a **high–pressure turbine**. The N1 and N2 rotors are mechanically independent. The N2 rotor drives the engine **gearboxes** (IDG, hydraulic, fuel, oil pumps). A bleed–air–powered starter motor is connected to the N2 rotor.

A dual–channel electronic engine control (**EEC**) regulates each engine. The EEC monitors autothrottle and flight crew inputs to automatically set engine thrust. Each engine has individual flight deck controls. Thrust is set by positioning the thrust levers. The thrust levers are positioned automatically by the autothrottle system or manually by the flight crew. The forward thrust levers control forward thrust from idle to maximum. The reverse thrust levers control thrust from reverse idle to maximum reverse.

Engines
Indications





- **Primary engine indications**
  - A/T limit
  - Thr mode
  - TAT
  - N1 indications
  - TAI
  - REV
  - EGT
  - N2 indications
- Fuel quantity indications
  - Fuel quantity
  - Fuel used
  - Fuel flow
- **Secondary engine indications**
  - Oil pressure
  - Oil quantity
  - Oil temperature
  - Engine vibration
- **Hydraulic indications (MFD)**
  - Hydraulic pressure
  - Hydraulic fluid quantity

Engines
Indications: Crew alerts (Upper DU)

Start valve open
Illuminated (amber) –
• steady – respective engine start valve open and air is supplied to starter
• blinking – uncommanded opening of start valve. Alert is displayed and solid amber boxes are displayed in unannunciated positions for that engine. All three boxes blink for ten seconds, then alert remains on steady and solid amber boxes are removed.

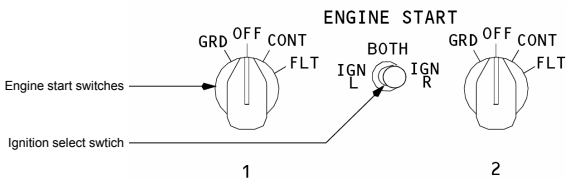
Low oil pressure
Illuminated (amber) –
• steady – oil press at or below red line
• blinking – with a condition of low oil pressure. Alert is displayed and solid amber boxes are displayed in unannunciated positions for that engine. All three boxes blink for ten seconds, then alert remains on steady and solid amber boxes are removed.

START VALVE OPEN
OIL FILTER BYPASS
LOW OIL PRESSURE

START VALVE OPEN
OIL FILTER BYPASS
LOW OIL PRESSURE

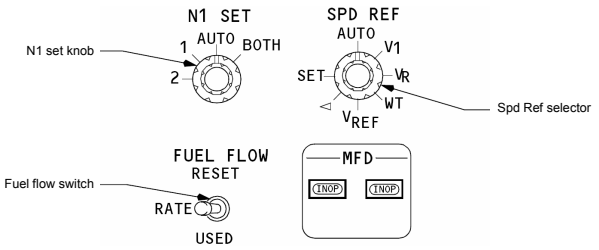
Oil filter bypass
Illuminated (amber) –
• steady – indicates an impending bypass of scavenge oil filter
• blinking – with an impending bypass. Alert is displayed and solid amber boxes are displayed in unannunciated positions for that engine. All three boxes blink for ten seconds, then alert remains on steady and solid amber boxes are removed

Engines
Controls & indicators: Engine start switches



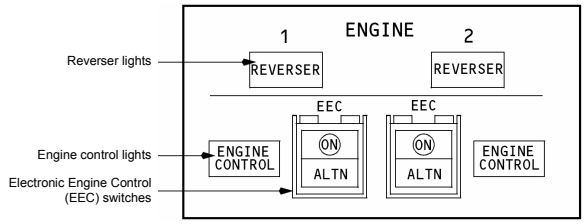
Engines

Controls & indicators: Engine display control panel



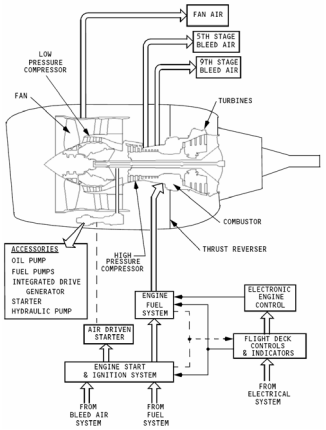
Engines

Control & indicators: Engine panel



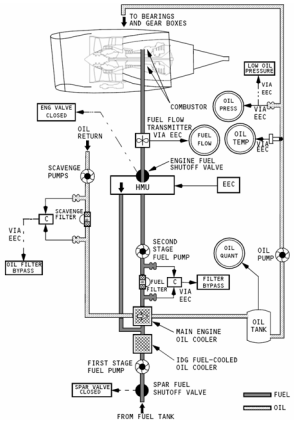
Engines

Powerplant schematic



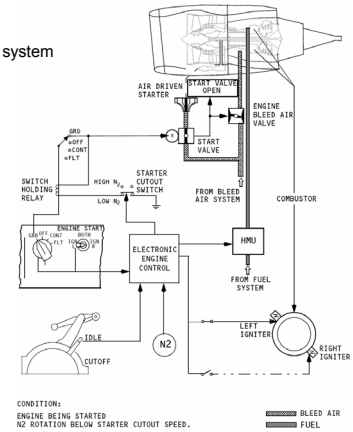
Engines

Fuel and oil system



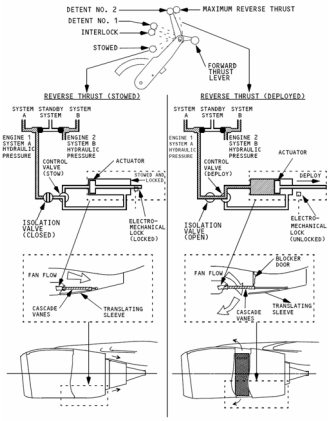
Engines

Start and ignition system



Engines

Trust reverser



Engines

Normal operation: Engine start

CAPTAIN	FIRST OFFICER
Announce engine start sequence.	
Normal starting sequence is 2, 1.	
Call "STARTING ENGINE No. ___."	
Position ENGINE START switch to GRD.	
Verify increase in N2 RPM.	
Acknowledge first officer's report.	Verify increase in oil pressure by the time engine is stabilized at idle and call "OIL PRESSURE RISING" when observed.
Position engine start lever to IDLE detent when: • N1 rotation is observed and • N2 RPM reaches 25% or (if 25% N2 is not achievable) • at max motoring and a minimum of 20% N2. Max motoring occurs when N2 acceleration is less than 1% in approximately 5 seconds.	
Verify fuel flow and EGT indication.	
At 56% N2 RPM check ENGINE START switch moves to OFF; if not, position start switch to OFF.	Verify START VALVE OPEN alert extinguishes as the ENGINE START switch moves to OFF and report "STARTER CUTOUT."
Monitor N1, N2, EGT, fuel flow and oil pressure for normal indications as the engine accelerates and stabilizes at idle.	

Note: Standard day, sea level, approximate stabilized idle indications for the CFM56–7 engine.

- N1 RPM – 20%
- N2 RPM – 59%
- EGT – 410°C**
- Fuel Flow – 272 KGPH

** Idle EGT may vary from 320°C – 520°C depending on OAT, bleed configuration, and engine conditions.

Starter Duty Cycle

- Limit each start attempt to a maximum of 2 minutes
- A minimum of 10 seconds is required between start attempts

CAUTION: Normal engine start considerations:

- Advancing engine start lever to idle prematurely can cause a "HOT" start.
- Keep hand on engine start lever while observing RPM, EGT and fuel flow until stabilized.
- If fuel is shutoff inadvertently (by closing engine start lever) do not reopen engine start lever in an attempt to restart engine.
- Failure of ENGINE START switch to hold in GRD until starter cutout RPM is reached can result in a "HOT" start. Do not re–engage ENGINE START switch until engine RPM is below 20% N2.

Note: Accomplish the ABORTED ENGINE START checklist for one or more of the following conditions:

- No N1 rotation before the engine start lever is raised to IDLE.
- No oil pressure indication by the time the engine is stabilized at idle.
- No increase in EGT within 10 seconds of raising the engine start lever to IDLE.
- No increase in, or a very slow increase in N1 or N2 after EGT indication.
- EGT rapidly approaching or exceeding the start limit.

Engines

Normal operation: Battery only start

Cleared for Start

- PACK switches ..... OFF
- ANTICOLLISION light switch ..... ON
- Ignition select switch ..... IGN-R

Engine Start

- Engine No. 1 start ..... Accomplish
  Only N1, N2, and oil quantity are displayed until the EECs are powered.
- Generator No. 1 switch ..... ON
- IRS mode selectors ..... NAV
- FMC/CDU ..... Set IRS position

WARNING: If engine No. 1 was started using a ground air source, to minimize the hazard to ground personnel, the external air should be disconnected and engine No. 2 started using the Engine Crossbleed Start procedure.

- Engine No. 2 start ..... Accomplish
- Generator No. 2 switch ..... ON

After Start

Complete the preliminary flight deck preparation by checking the following items:

- MACH AIRSPEED WARNING test switches ..... Push
- STALL WARNING TEST switches ..... Push
- REVERSER lights ..... Check
- EEC switches ..... ALTN then ON
- Passenger oxygen switch ..... NORMAL
- Crew oxygen ..... Check

Accomplish panel scan to insure that the flight deck preparation procedure is complete.

- AFTER START checklist ..... Accomplish
- IRS alignment ..... Complete & no flags

The airplane is ready for taxi. Refer to the normal checklists for subsequent checks.

Engines

Normal operation: Engine start from ground air source

Starting with Ground Air Source (AC electrical power available)

Engine No. 1 must be started first.

When cleared to start:

- APU BLEED air switch ..... OFF
- Engine No. 1 start ..... Accomplish
  Use normal start procedures.

WARNING: To minimize the hazard to ground personnel, the external air should be disconnected, and engine No. 2 started using the Engine Crossbleed Start procedure.

Engines

Normal operation: Crossbleed start

Engine Crossbleed Start

Prior to using this procedure, ensure that the area to the rear is clear.

- Engine BLEED air switches ..... ON
- APU BLEED air switch ..... OFF
- PACK switches ..... OFF
- ISOLATION VALVE switch ..... AUTO
  Ensures bleed air supply for engine start.
- Engine thrust lever (operating engine) ..... Advance thrust lever until bleed duct pressure indicates 30 PSI
- Non–operating engine ..... Start
  Use normal start procedures with crossbleed air.

After starter cutout, adjust thrust on both engines, as required.

Engines

Non-normal operation: Inflight engine start

INFLIGHT ENGINE START

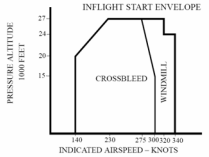
Condition: **Engine start is desired after a shutdown with no fire or apparent damage.**

Note: Oil quantity indication as low as zero is normal if windmilling N2 RPM is below approximately 8%.

Complete the ENGINE FAILURE/SHUTDOWN checklist before attempting an inflight engine start.

INFLIGHT START ENVELOPE . . . . . CHECK
[Starts not assured outside of the inflight start envelope.]

Note: For engines shut down more than one hour, a crossbleed start is required.



THRUST LEVER . . . . . CLOSE

ENGINE START LEVER . . . . . CUTOFF

If crossbleed start is required:

PACK SWITCH (affected side) . . . . . OFF

DUCT PRESSURE . . . . . MINIMUM 30 PSI
If required, advance the thrust lever to increase duct pressure.

ENGINE START SWITCH . . . . . GRD/FLT
Use GRD if crossbleed start is required.

ENGINE START LEVER . . . . . IDLE DETENT
Position engine start lever to IDLE detent at a minimum of 11% N2.
Monitor EGT to ensure it does not rise rapidly or exceed the start limit of 725° C during the start attempt.

If no increase in EGT is observed within 30 seconds:

ENGINE START LEVER . . . . . CUTOFF

ENGINE START SWITCH . . . . . OFF

Note: If engine has been shutdown for more than 1 hour, multiple start attempts may be required.

After engine start:

ELECTRICAL . . . . . GENERATOR ON

PACK SWITCH . . . . . AUTO

ENGINE START SWITCH . . . . . AS REQUIRED

APU . . . . . AS REQUIRED

TRANSPONDER MODE SELECTOR . . . . . TA/RA

Engines

Non-normal operation: Aborted engine start

ABORTED ENGINE START

Condition: **One or more of the following conditions:**

- No N1 rotation before the engine start lever is raised to IDLE
- No oil pressure indication by the time the engine is stabilized at idle
- No increase in EGT, within 10 seconds on the ground or 30 seconds in flight, after the engine start lever is raised to IDLE
- No increase in, or a very slow increase in N1 or N2 after EGT indication
- EGT rapidly approaching or exceeding the start limit

Before engine start lever raised to IDLE:

ENGINE START SWITCH . . . . . OFF

After engine start lever raised to IDLE:

Before starter cutout:

ENGINE START LEVER . . . . . CUTOFF
Continue to motor the engine for 60 seconds.
[Clears fuel and cools engine components.]

ENGINE START SWITCH . . . . . OFF

After starter cutout:

ENGINE START LEVER . . . . . CUTOFF

After N2 decreases to below 20%:

ENGINE START SWITCH . . . . . GRD
Motor the engine for 60 seconds.
[Clears fuel and cools engine components.]

ENGINE START SWITCH . . . . . OFF

Engines

Non-normal operation:

Inflight engine fuel leak

INFLIGHT ENGINE FUEL LEAK

Condition: **An inflight engine fuel leak is suspected or confirmed by one or more of the following:**

- visual observation of fuel spray from strut/engine
- excessive engine fuel flow or fuel imbalance indication
- total fuel quantity decreasing at an abnormal rate
- IMBAL indication
- USING RSV FUEL message
- INSUFFICIENT FUEL message

CENTER FUEL PUMP SWITCHES . . . . . OFF

Note: Fuel CONFIG indication may be displayed with fuel in the center tank.

CROSSFEED SELECTOR . . . . . CLOSE

Identify affected engine by observing one wing fuel tank quantity decreasing faster than the other. An increasing fuel imbalance of approximately 227 kgs or more in 30 minutes should be considered a fuel leak. Conditions permitting, visually check for engine fuel leak.

After the affected engine is identified, or it is determined that no leak exists, resume normal fuel management.

If both wing tank quantities are decreasing at the same rate:

Note: Confirm FMC Route is correct.

PROGRESS PAGE 1 . . . . . SELECT

DESTINATION FUEL ESTIMATE . . . . . CHECK

Verify adequate fuel available to complete flight.

If fuel leak is confirmed:

Flight conditions permitting, accomplish the ENGINE FAILURE/SHUTDOWN procedure to stop the leak.

Engines

Non-normal operation: Loss of thrust on both engines

LOSS OF THRUST ON BOTH ENGINES

Condition: **Loss of all thrust on both engines accompanied by illumination of both ENG FAIL alerts.**

ENGINE START SWITCHES. . . . . FLT

ENGINE START LEVERS. . . . . CUTOFF

EGT decreasing:

ENGINE START LEVERS . . . . . IDLE DETENT

If EGT reaches 950°C, repeat the above steps.

Note: In moderate to heavy rain it may take up to 3 minutes to accelerate to idle.

APU (if available) . . . . . START & ON BUS

Do not wait for successful engine start(s) prior to starting APU.

[The APU has demonstrated the capability to provide electrical and pneumatic power up to 20,000 feet. APU may be placed on either or both busses.]

If neither restart is successful and N2 is below 11%:

WING ANTI–ICE SWITCH . . . . . OFF

PACK SWITCHES . . . . . OFF

APU BLEED AIR SWITCH . . . . . ON

IGNITION SELECT SWITCH . . . . . BOTH

EITHER ENGINE START SWITCH . . . . . GRD

When engine parameters have stabilized:

APU BLEED AIR SWITCH . . . . . OFF

ENGINE START SWITCH . . . . . FLT

THRUST LEVER . . . . . ADVANCE

GENERATOR SWITCH . . . . . ON

PACK SWITCH . . . . . AUTO

Accomplish the INFLIGHT ENGINE START checklist to start the other engine.

If neither IRS attitude display recovers after a transfer bus is restored:

IRS MODE SELECTOR SWITCHES . . . . . ATT

Maintain wings level, constant speed flight until attitude displays recover (approximately 30 seconds).

MAGNETIC HEADING . . . . . ENTER

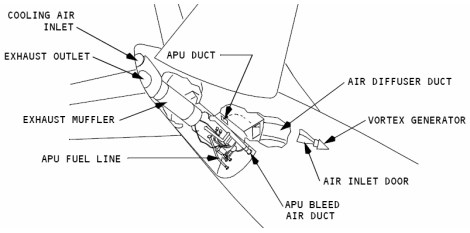
APU . . . . . AS REQUIRED

Auxiliary Power Unit (APU)

Overview

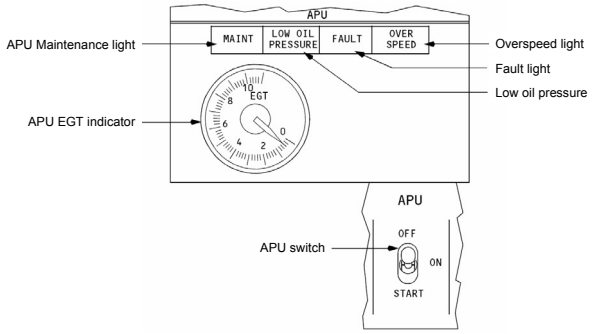
The auxiliary power unit (APU) is a self–contained gas turbine engine installed within a fireproof compartment located in the tail of the airplane. The APU supplies bleed air for engine starting or air conditioning. An AC electrical generator on the APU provides an auxiliary AC power source.

System components



Auxiliary Power Unit (APU)

Control & indicators: Engine panel



Auxiliary Power Unit (APU)

Normal operation

Start procedures

• The automatic start sequence begins by moving the APU switch momentarily to START. This initiates opening of the air inlet door. When the APU inlet door reaches the full open position the start sequence begins. After the APU reaches the proper speed, ignition and fuel are provided. When the APU is ready to accept a bleed air or electrical load the APU GEN OFF BUS light illuminates.

Note: When the APU is started using battery power only, there is no indication on the electrical metering panel that the APU generator has come on line and is ready to be selected. Both the frequency and voltage readings are zero until the APU generator is placed on line.

• If the APU does not reach the proper speed with the proper acceleration rate within the time limit of the starter, the start cycle automatically terminates. The start cycle may take as long as 120 seconds. Automatic shutdown occurs in the event of EGT exceedance.

• If the start fails or the APU GEN OFF BUS light fails to illuminate by the end of the start cycle, a system failure has occurred and the FAULT light illuminates.

• **Operate the APU for one full minute before using it as a bleed air source.** This one minute stabilization is recommended to extend the service life of the APU.

Auxiliary Power Unit (APU)

Normal operation

Shutdown procedures

• **Operate the APU for one full minute with no bleed air load prior to shutdown.** This cooling period is recommended to extend the service life of the APU. When the APU switch is moved to OFF, this time delay is met automatically.

• Moving the APU switch to OFF
- trips the APU generator
- closes the APU bleed air valve
- extinguishes the APU GEN OFF BUS light.

• Shutdown occurs automatically after **60 seconds**. When the APU speed decreases sufficiently during shutdown, the fuel valve and inlet door close. If the fuel valve does not close, the FAULT light will illuminate after approximately 30 seconds.

• An immediate shutdown can be accomplished by pulling the APU fire switch.

Fuel system

Overview

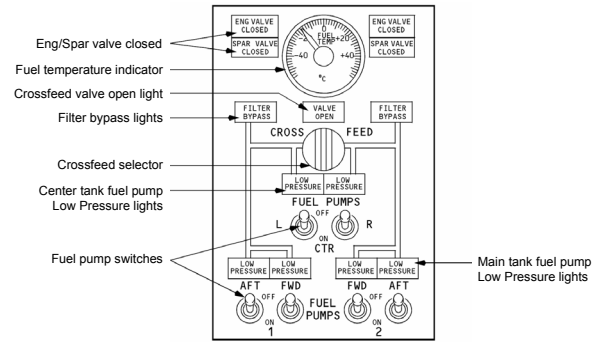
The fuel system supplies fuel to the engines and the APU. Fuel is contained in three tanks located within the wings and wing center section

TANK	LITERS	KILOGRAMS*
NO. 1	4,876	3,915
NO. 2	4,876	3,915
CENTER	16,273	13,066
TOTAL	26,025	20,896

* Usable fuel at level attitude, fuel density 0.8029 kg/liter

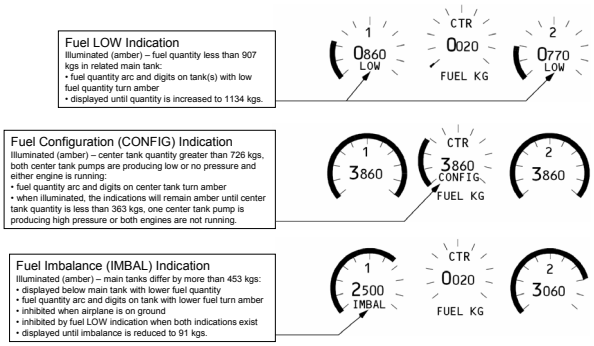
Fuel system

Control & indicators: Fuel control panel



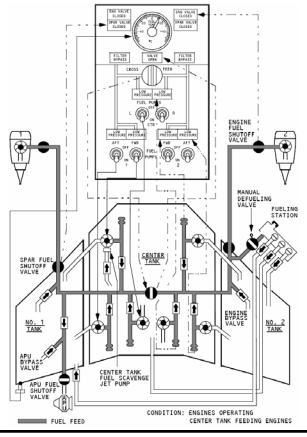
Fuel system

Control & indications: Fuel alert indications



Fuel system

System schematic



Fuel system

Normal operation:

Fuel balancing

Fuel Balancing

If a fuel leak is suspected:

Accomplish the INFLIGHT ENGINE FUEL LEAK checklist.

Maintain main tank No. 1 and No. 2 fuel balance within limitations.

Note: Fuel pump pressure should be supplied to the engines at all times. At high altitude, without fuel pump pressure, thrust deterioration or engine flameout may occur.

If the center tank contains fuel:

Center tank fuel pump switches ..... OFF
[Fuel CONFIG indication may be displayed with fuel in the center tank.]

Crossfeed selector ..... Open

Fuel pump switches (low tank) ..... OFF

When quantities are balanced:

Fuel pump switches (main tank) ..... ON

Center tank fuel pump switches ..... ON

Crossfeed selector ..... Close

If the center tank contains no fuel:

Crossfeed selector ..... Open

Fuel pump switches (low tank) ..... OFF

When quantities are balanced:

Fuel pump switches ..... ON

Crossfeed selector ..... Close

Köszönöm a figyelmet!

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