



# Engine Start Guide

Q400 SOP & Technical Training

### **Engine Starting - Electrics**

#### *Starting modes*

- Battery start
- Generator assisted starting (cross start)
- DC EXT Power start
- APU assisted starting

OM/B Vol. III does not describe AC EXT Power assisted starts. Refer to OM/B I 2.3.3.6.

### **Starting from Batteries**

- Only MAIN and AUX batteries (in parallel) deliver energy for the starting process.
- STBY battery is diode isolated from the left main bus and ensures an acceptable level of voltage on the essential busses during engine start.
- Avoid delayed start-up and switch off all unnecessary equipment.
- Avoid Battery starts to save engine lifetime. If a Battery Start was performed, an ACARS Message to MOC is required to track the number of Battery Starts per engine.
- A Techlog entry is required only, if start progressed not normal.
- Certified max. ITT applies for Battery Starts: 920°C
- After Start, charge rate will reduce after approx. 3 minutes.
- While charging, BAT Voltage and temperature must be monitored on the MFD ELEC page.
- Second Engine will be “cross started” (see next Chapter).

### **Generator assisted starting**

Also known as “cross start”. ENG1 started during pushback or starting of the second engine after an Battery Start of the first engine.

- Right DC GEN is connected to right main bus as soon as the EXT PWR switch is placed to OFF.
- In parallel with the MAIN & AUX batteries, the right DC GEN will start the other engine. During the start and 15 seconds following it, the DC GCUs will receive a “current limit” signal. This will limit the current the opposite side generator will contribute to the starting and also to limit the current the starter generator (in generating mode) will supply to the loads.

### **Starting from DC External Power**

- Upon selection of engine start, contractors connecting the MAIN and AUX batteries to the main busses are closed automatically.
- STBY battery is isolated to ensure essential bus voltage.
- When starting is terminated, the power source is still the external power. When the DC EXT PWR switch is OFF after engine start, the DC GENs come on line, if the GEN switches are ON.
- Both vertical bus ties connecting the main to the secondary busses will remain closed until DC power is available from the TRUs.

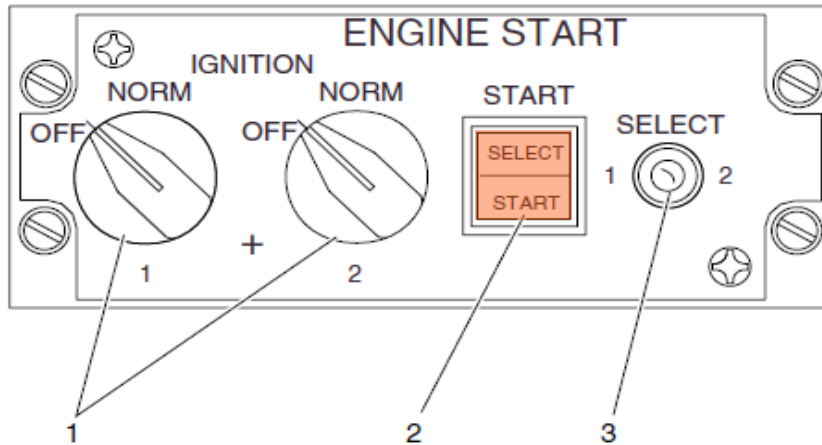
If the external voltage is

- more than 31 +0,5/-0,74 VDC
- or less than 22 +/- 1 VDC

an over- / under voltage condition will cause the external ground power to stop supplying electrical power to the aeroplane.

If the external power over/under voltage is rectified, the external power source can be reselected by moving the DC EXT PWR switch to OFF and then to EXT PWR (on).

**Engine Start control panel**



***IGNITION CONTROL SWITCH***

OFF            FADEC disables ignition

NORM         FADEC activates ignition during engine start, flameout or surge

***ENGINE START SWITCHLIGHT***

**SELECT**     indicates start control circuit is armed

PUSH         **START** segment indicates engine start has been initialized

***ENGINE START SELECT SWITCH***

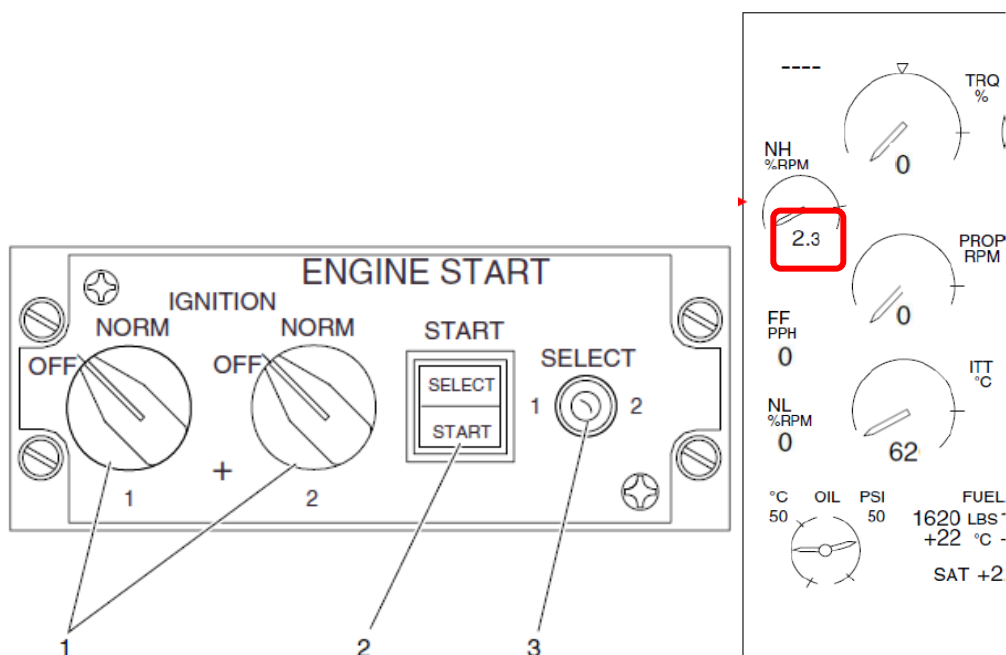
1              arms start control circuits for #1 Engine **SELECT** light illuminates

2              arms start control circuits for #2 Engine **SELECT** light illuminates

## Ground Start

Starting is accomplished using the:

- STARTER/GENERATOR in STARTER mode,
  - IGNITION control system,
  - FUEL control system.
- The STARTER/GENERATOR rotates the High Pressure Compressor (NH ) through the accessory gearbox to develop the necessary airflow and engine RPM before Fuel is introduced.
- The Start System is armed by selecting the engine to be started with the ENGINE START SELECT switch on the ENGINE START panel. (3)
- The Start System is turned on by pressing the ENGINE START Switch. (2)
- The Start sequence is initiated by pressing the Engine Start Switch AND selecting the Condition Lever to START & FEATHER at the first indication of NH.



From now on, FADEC controls the starting sequence:

**When  $N_H$  is 8%,**

- **IGNITION is started** and
- **FUEL FLOW** is scheduled as a function of  $N_H$ , ambient Temperature and atmospheric air pressure.

**When  $N_H$  is 50% (+/- 2%) or greater,**

- **IGNITION is terminated** and
- the **STARTETR cuts out** (ENGINE START SELECT SWITCH is automatically released to the center position and the START caption in the switch light goes out).

**FADEC controls engine run-up to the requested  $N_H$  speed.**

**Minimum  $N_H$  is 64,2%.**

Start is complete, when the **SELECT** light goes out.

### **Additional information**

- At 8%  $N_H$  only **one** of the two igniters is turned on. This is to identify any failures in the dual channel ignition system. If the engine does not light up within **8 seconds** of fuel being selected on, FADEC turns on **both** igniters and logs an ignition fault. This fault is not shown anywhere on the instruments, pilots however notice a later than normal light up.
- Light up is defined as an ITT increase of **20°C**.
- **Inform MOC via ACARS about any late light up.**

### **FADEC auto start abort features**

During GROUND STARTS ONLY, FADEC provides one protection:

- **Over temperature protection:** to ensure that the engine start does not cause over temperature, FADEC has active ITT limiting to reduce the fuel flow if required (below the standard start schedule fuel flow rate).

and three auto start abort features:

- **Wet start protection:** the Start is automatically terminated, if the ITT does not rise within **16 seconds** of fuel flow being selected ON.
- **Hot start protection:** at **920°C** ITT
- **Hung start protection:** NH does not reach **50%** within **70 seconds**.

Be aware that FADEC protection takes effect, when the limit is already reached.  
(70 seconds max. starter cranking, 920° ITT)

FADEC protection does not exist during inflight engine starts.

### **LGW COMPANY LIMITS FOR ITT:**

**810°C for DC EXT / AC EXT / APU Start**

**920°C for BATTERY Start (AFM Limit).**

**920°C for inflight engine starts.**

### **STARTER CRANKING LIMITS**

**1<sup>st</sup> attempt    70 sec., wait 2 minutes**

**2<sup>nd</sup> attempt    70 sec., wait 2 minutes**

**3<sup>rd</sup> attempt    70 sec., wait 30 minutes**

It is already an attempt, if the starter started to turn the engine.

(It is mainly the initial 1000+ Ampere current which heats up the starter.)

### Inflight Start

Similar to ground starts, except:

- both Igniters are commanded on during the start right from the beginning,
- automatic start abort features of FADEC are disabled (!!),
- the FADEC does not actively limit ITT by reducing fuel schedule to the engines during start,
- Inflight Starts will be carried out by the PNF.

### Legend for SOP description

**CM1 is BLUE**

**CM2 is RED**

**PF is GREEN**

**both at the same time is black**

**Pilot flying starts the Engines**

### Sequence of Events

Startup clearance is received

Before Start Checklist is accomplished.

CM1 communicates with ramp staff

CM1 calls „ENGINE TWO“

CM2 looks out of the right window and checks danger area clear.

CM2 switches off APU BLEED, if selected ON.



CM2 calls „CHECKED“

(from now on, roles split in PF/PNF)

With the inboard hand, PF moves START SELECT switch to ENG#2 and presses the START BUTTON. The button must be pressed relatively firmly and held pressed for approx. 1 second. With the outboard hand, the stop watches are pressed at the same time.

PF and PNF check start cycle engagement (whistling noise in headset and START caption lights up in the ENGINE START switch light).

PF moves Cond. Lever #2 to START & FEATHER as soon as N<sub>H</sub> starts to rise above 0.

PF and PNF check

- ITT development
- HYD and OIL pressure increase
- Starter cycle disengagement at 50% N<sub>H</sub>
- stabilized engine parameters
- Caution and Warning lights

(Roles split in CM1 and CM2)

CM1 communicates with ground staff.

CM1 checks BAT load less than 0,4 (always, to charge BAT for initial high current)

CM1 looks out of the left window and checks danger area clear

CM1 calls „ENGINE ONE“

## Engine Start Guide

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CM2 calls „Checked“

(Again, roles split in PF/PNF)

With the inboard hand, PF moves START SELECT switch to ENG#1 and presses the START BUTTON. With the outboard hand, the stop watches are pressed at the same time.

PF and PNF check start cycle engagement.

PF moves Cond. Lever #1 to START & FEATHER as soon as  $N_H$  starts to rise above 0.

PF and PNF check

- ITT development
- HYD and OIL pressure increase
- Starter cycle disengagement at 50%  $N_H$
- stabilized engine parameters
- Caution and Warning lights

(Roles split in CM1 and CM2)

CM1 switches

- APU GEN / EXT PWR OFF
- MAIN BUS TIE OFF
- Checks DC GEN #1 and #2 on line
- APU OFF (not earlier, as DC GENs might not come on line )

CM2 at the same time switches

- BLEEDS ON/NORM
- RECIRC FAN ON (if not ON already)

CM1 instructs ramp staff to prepare the aircraft for taxi / push back.

After Start Checklist or After Start Checklist to the line.

### **Engine Protection**

NEVER RELY ON FADEC PROTECTIONS.

EVERY CREW MEMBER MAY CALL "START MALFUNCTION" AT ANY TIME.

Without delay, PF will perform the ABORTED ENGINE START Memory Items immediately:

**CONDITION LEVER    FUEL    OFF**  
**START SELECT        OFF**

*No Starter cut out / Starter failure*

If no starter cycle disengagement at 50%  $N_H$  (+/- 2 %) and/or if the START Light remains illuminated, immediately perform the "NO STARTER CUTOFF CHECKLIST".

If the SELECT light remains on > 15 seconds after starter cut out, perform the "STARTER FAILURE CHECKLIST".

*"CLEARING AN ENGINE IS REQUIRED", if*

- there was fuel flow indication > 0 but no light up (ITT rise),
- or a hung start,
- or if deemed necessary by the Crew or Maintenance.

### **RESPECT STARTER CRANKING LIMITS**

**As soon as the Starter began turning, the cycle is started!**

**BE CAREFUL WITH SUBSEQUENT ENGINE STARTS.**

After a wet start (no light up) you might want to check circuit breakers.

LEFT CB PANEL (square)

ENG1 IGN A            J5

ENG2 IGN A            K5

RIGHT CB PANEL

ENG1 IGN B            J5

ENG2 IGN B            K5

If cleared by Maintenance / MOC , reset tripped CBs and a subsequent Engine Start most likely will be successful.

If source  
for  
Start malfunction  
is unknown,  
**do not try again.**