



B737 NG CBT - FUEL

COURSE OUTLINES

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COURSE START

1-The material contained in this training program is based on the information obtained from current state, local and company regulations and it is to be used for training purposes only. At the time of designing this program contained then current information. In the event of conflict between data provided herein and that in publications issued by the authority, the authority shall take precedence.

FUEL SYSTEM

2-This chapter introduces you to the airplane fuel system and provides an overview of its organization, operation, controls and indications. Here is the chapter outline: * Introduction * Fuel Tanks * Engine Feed * APU Feed * Ground Fueling/Defueling/Transfer * Fuel Control Panel * Fuel Quantity Indication and Alerts * Fuel Panel Controls and Indications Review

INTRODUCTION

3-The purpose of fuel system is to supply fuel to the engines and the auxiliary power unit (APU).

4-Fuel system primarily consists of these subsystems: fuel storage, engine fuel feed, APU fuel feed, ground fueling/defueling/transfer, fuel control panel and fuel quantity indication.

FUEL STORAGE

5-The fuel tanks store fuel for use by the engines and the APU. The airplane has three fuel tanks: main tank number 1 is in the left wing; main tank number 2 is in the right wing; and the center tank is in the fuselage and the inboard section of each wing. The surge tanks in the outboard section of the wings collect fuel overflow only. Each main tank has a usable fuel capacity of 3,915 kgs. The usable fuel capacity of the center tank is 13,066 kgs. Thus, total usable fuel capacity of the airplane is 20,896 kgs.

ENGINE FUEL FEED

6-The engine fuel feed system supplies fuel under pressure to the engines from main tank number 1, main tank number 2, and the center tank.

7-The engine fuel feed system uses these primary components to supply fuel to the engines: the fuel boost pumps, fuel manifolds, crossfeed valve, fuel shutoff valves, suction feed and fuel scavenge system. Check valves are also located throughout the feed system to ensure the proper direction of fuel flow and to prevent reverse flow from fuel manifold into the fuel tanks.

ENGINE FEED - Fuel Pumps

8-Engine fuel feed system incorporates six fuel boost pumps for the engine feed. All fuel boost pumps are driven by AC electrical power and submerged in fuel for cooling. Individual pressure sensors fitted to outlet of the pumps monitor the output pressure of each pump.

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9-The center tank has two fuel boost pumps, one left and one right. There are forward and aft fuel boost pumps for each main tank.

10-Main tank number 1 forward and aft fuel pumps, and the left center fuel pump supply fuel to the engine number 1. Main tank number 2 forward and aft fuel pumps, and the right center fuel pump supply fuel to the engine number 2.

11-The center tank boost pumps supply fuel at a higher pressure than the pumps in the main tanks. Therefore, the fuel in the center tank is used before the fuel in the main tanks. This sequence helps to relieve the wing bending stress.

Fuel Manifolds

12-Engine fuel manifolds consist of fuel lines which supply engines with fuel.

Crossfeed Valve

13-The crossfeed valve connects the left and right engine fuel feed manifolds and enables the feed of the engine number 2 from left tank or vice versa. When it is open, one fuel tank supplies fuel to both engines. Note that continuous use of crossfeed will result in fuel imbalance gradually.

Fuel Shutoff Valves

14-A spar fuel shutoff valve and an engine fuel shutoff valve fitted in fuel line to each engine, control fuel flow to the engines. Spar fuel shut off valves are electrically powered from the hot battery bus. Engine fuel shutoff valves are electrically powered from the battery bus. The engine start levers and the engine fire switches control the spar fuel shutoff valves and engine fuel shutoff valves.

15-Whenever an engine start lever is moved to the "CUTOFF" position, the respective spar fuel shutoff valve and the engine fuel shutoff valve close, cutting off the fuel flow to the respective engine.

16-Likewise, whenever respective engine fire switch is pulled, both the spar fuel shutoff valves and the engine fuel shutoff valve close, cutting off the fuel flow to the respective engine.

Suction Feed

17-Engine fuel feed system also has suction feeds from main tank number 1 and main tank number 2. Suction feed occurs when output pressure of fuel boost pumps in one main tank is low or both pumps are off and the crossfeed valve is closed.

18-For instance if both fuel boost pumps in the main tank number 1 have failed and the crossfeed valve is closed, the mechanical pump on engine number 1 draws fuel from its main tank through a suction feed line that bypasses the fuel boost pumps.

19-When an engine is running on suction feed, you may experience the following phenomenon: as the aircraft climbs to cruise altitude, dissolved air in the fuel is released due to the decrease in air pressure; the air bubbles released by the fuel

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may collect in the suction line interrupting the fuel supply. Thus, thrust deterioration or engine flameout may occur as a result of the fuel flow reduction. After reaching cruise altitude, the dissolved air is eventually consumed and the engine may operate on suction feed at cruise power.

Fuel Scavenge System

20-A center tank fuel scavenge system is incorporated in the forward fuel boost pump in main tank number 1. The purpose of scavenge system is to reduce the amount of non-usable fuel in the center tank. The center tank fuel scavenge system consists of a jet pump with no movable parts. Let's see how the center tank fuel scavenge system operates.

21-As you have seen earlier, the center tank fuel is used before the main tank fuel. However, there is still some fuel remaining in the center tank, because center boost pumps' inlets are not at the lowest points of the tank. As the main tanks fuel boost pumps run, the quantity of fuel in main tank number 1 and main tank number 2 decrease. When the fuel quantity in main tank No.1 is about one-half empty, the fuel scavenge pump removes any remaining fuel from the center tank and transfers it to main tank No.1 automatically. Once the fuel scavenge process begins, it continues for the rest of the flight.

APU FEED

22-The APU fuel feed system supplies fuel to the APU from the left side of the fuel manifold as long as the center tank boost pumps or the boost pumps in main tank No. 1 and main tank No. 2 are operating. If the fuel boost pumps are not operating, fuel is suction fed from main tank number 1. An APU fuel shutoff valve isolates fuel flow from the left engine fuel feed manifold to the APU.

GROUND FUELING / DEFUELING / TRANSFER

23-The fuel tanks need to be refilled rapidly and safely. This is achieved through the pressure fueling system.

24-Pressure fueling system consists of a single-point pressure fueling station in the right wing. The fueling station allows for rapid refueling and defueling all fuel tanks. The fueling station is also used for the transfer of fuel from tank to tank on the ground. A shutoff system closes the fueling valve in each fuel tank automatically when the tank is full.

25-A manual defuel valve connects the right engine fuel feed manifold with the fueling station. Moving the defuel valve handle in the OPEN position permits removal of fuel from the fuel tanks or fuel transfer from one fuel tank to another.

26-The fueling station incorporates a control panel which is used to control the fueling and defueling process. The fueling indication test switch is a three-position switch. The switch is spring loaded to the center (OFF) position. TEST GAGES position is selected to do a test of the fuel quantity indicators. When the switch is in the FUEL DOOR SWITCH BYPASS position, it energizes the fueling panel if refueling power control relay fails. The blue valve position lights come on when there is power to the fueling shutoff valves. The lights are extinguished if the power is not available. The fueling valve control switches are two-position switches. When the switch is selected to OPEN, the fueling valve solenoid energizes and the valve opens if fuel pressure is available at the fueling manifold. In the CLOSED position, the fueling valve solenoid de-

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energizes and the valve closes. The fuel indicators show total usable fuel quantity in associated tanks.

27-On the ground fuel quantity in the tanks can be measured manually with fuel measuring sticks installed at multiple points in each tank. Reading is obtained by unlocking and lowering the stick from the bottom of the tank and latching it magnetically to an internal float. This method of fuel quantity measurement is used to verify the fuel quantity indicated by fuel indicators.

FUEL CONTROL PANEL

28-The fuel control panel is on the forward overhead panel. The panel incorporates pumps' switches, pumps' LOW PRESSURE lights, a CROSSFEED SELECTOR and a crossfeed VALVE OPEN light, engine valve closed and SPAR VALVE CLOSED lights, FILTER BYPASS lights and a fuel temperature indicator.

29-You find six fuel pump switches on the panel. Center tank left and right pump switches, main tank number 1 aft and forward pump switches and main tank number 2 aft and forward pump switches. Pump switches let you activate or deactivate the respective fuel boost pump. A low pressure light over each pump switch allows for monitoring pump output pressure. Let's first take a look at operation of center tank fuel switches and lights.

30-When the center pump switches are in the OFF position, the LOW PRESSURE lights are extinguished. When you position the left center pump switch to ON, center tank left fuel boost pump is energized. The pump supplies fuel to engine number 1 fuel manifold. Positioning the right center pump switch to ON, activates center tank right fuel boost pump which supplies fuel to engine number 2 fuel manifold. As long as the pumps' output pressures are normal, the lights remain extinguished. A LOW PRESSURE light in amber comes on for either center tank fuel boost pump if the pressure from indicated pump is low when associated pump switch is in the ON position.

31-If both LOW PRESSURE lights illuminate when both center tank fuel switches are in the ON position, MASTER CAUTION and FUEL system annunciator lights on the glareshield panel also illuminate. In this situation, you should turn both center tank fuel pump switches OFF. Do not forget that center tank fuel is no longer usable and fuel in the main tanks may not be sufficient for the planned flight.

32-Illumination of a single LOW PRESSURE light when both center tank fuel switches are in the ON position, causes MASTER CAUTION and FUEL system annunciator lights to illuminate during a recall.

33-When aft and forward pump switches are in OFF position, the LOW PRESSURE lights are illuminated. When aft and forward pump switches of a main tank are turned ON, electrical power is applied to the respective pumps. The pumps supply fuel to the related engine fuel manifold, when the center tank is empty. When the pressure from either pump is low, A LOW PRESSURE light in amber illuminates for the associated main tank fuel pump. The light extinguishes when the pump output pressure is normal.

34-When both fuel pump LOW PRESSURE lights illuminate for the same main tank, MASTER CAUTION and FUEL system

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annunciators lights on the glareshield panel also illuminate. This situation may cause thrust deterioration or engine flameout at high altitude.

35-Illumination of a single LOW PRESSURE light causes MASTER CAUTION and FUEL system annunciators lights to illuminate during a recall.

36-CROSSFEED SELECTOR on the fuel panel allows you to control the crossfeed valve. Crossfeed VALVE OPEN light over the selector indicates the position of the crossfeed valve. When the selector is in closed position, as seen on the panel shown, the crossfeed valve is closed. Therefore engine No.1 and engine No.2 fuel manifolds are isolated, and crossfeed VALVE OPEN light is off. When the selector is moved to open the position, crossfeed VALVE OPEN light illuminates bright blue which means that the valve is in transit, or, the valve is not in the commanded position. When the valve is open, the crossfeed VALVE OPEN light becomes dim indicating that engine No.1 and engine No. 2 fuel manifolds are connected.

37-ENGINE VALVE CLOSED and SPAR VALVE CLOSED lights indicate the positions of their associated fuel shutoff valves. When the valves are in the open position, the lights are extinguished. The associated VALVE CLOSED light illuminates bright blue when the indicated valve is in transit, or, not in the position commanded by engine start lever or engine fire switch. When the valve is closed, the light is on dim. Now you see the operation of other valves and their associated lights.

38-Fuel FILTER BYPASS lights are extinguished as long as the fuel filters are functioning normally. When either fuel filter becomes clogged due to contamination, the respective fuel FILTER BYPASS alert illuminates on the fuel control panel indicating that fuel is about to bypass the filter and unfiltered fuel is to be supplied to the related engine.

39-The fuel temperature indicator on the fuel control panel shows the fuel temperature which is obtained through a sensor located in the main tank No.1. Maximum tank fuel temperature is 49°C. The minimum tank fuel temperature prior to takeoff and in-flight is -43°C, or 3°C above the fuel freezing point temperature, whichever is higher.

FUEL QUANTITY INDICATION

40-The fuel quantity indication system consists of a number of fuel probes and compensators located in each fuel tank. The probes measure the fuel weight and transmit a signal proportional to the fuel weight to a fuel quantity processor. Compensators correct for differences in fuel properties and transmit a signal in proportion to fuel characteristic to the fuel quantity processor. The fuel quantity processor unit uses these signals to calculate fuel quantity in each tank. The fuel quantity in each tank is displayed on the upper display unit and on the fueling station panel.

41-On the upper engine display, fuel quantity in each tank is displayed with white digits and white arcs. The fuel display also provides fuel alert indications. Let's take a look at these alerts in detail.

42-The fuel display provides three fuel alert indications: Fuel Low Alert, Fuel Configuration Alert and Fuel Imbalance Alert.

Fuel Low Alert

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43-When the fuel quantity is less than 907 kgs in either main tank No.1 or main tank No.2, an amber alert appears on the affected indicator and the quantity digits and arc color change to amber. When fuel quantity in the related tank is more than 1134 kgs, the low fuel alert disappears and the quantity digits and arc return to normal when fuel quantity in the related tank is more than 1134 kgs.

Fuel Configuration Alert

44-An amber fuel configuration alert appears on the center tank fuel quantity indicator and the quantity digits and arc color change to amber when all of the following conditions exist: at least one engine is running, center tank fuel quantity is more than 726 kgs and both center fuel tank pumps are producing low or no pressure or both center tank pump switches are selected to off.

45-The fuel configuration alert remains on until one or more of these conditions exist: both engines are not running, there is 363 kgs or less fuel in the center tank and at least one center tank fuel pump is producing high pressure or selected to ON. When the condition is met, the alert goes away and the quantity digits and arc on the center tank fuel quantity indicator return to normal.

Fuel Imbalance Alert

46-When there is a fuel quantity difference of 453 kgs or more between main tank No. 1 and main tank No. 2 the fuel imbalance alert shows below the main tank with lower fuel quantity. When the difference between tanks is 91 kgs or less, the fuel imbalance alert on the related main tank fuel quantity indicator goes away and the quantity digits and arc return to normal.

47-You should note the followings in fuel alert indications: the fuel imbalance alert only appears when the airplane is in the air. It is inhibited when airplane is on ground.

48-If both low fuel condition and fuel imbalance condition happen at the same time, fuel LOW alert is shown on the display and the fuel imbalance alert is inhibited.

49-When a fuel imbalance alert shows on the indicator, you should observe the fuel quantity in the center tank before taking any corrective action. If the center tank contains fuel; turn the center tank fuel switches to OFF, move the crossfeed valve to OPEN position, then turn off the boost pumps in the main fuel tank that has less fuel. When the fuel quantities in the main tanks are balanced, move the main tank switches to ON, then turn the center tank fuel switches to ON and close the crossfeed valve.

50-If the center tank contains no fuel, when a fuel imbalance alert shows follow these procedures: move the crossfeed valve to OPEN position, then turns off the boost pumps in the main fuel tank that has less fuel. When the fuel quantities in the main tanks are balanced, move the main tank switches to ON and then close the crossfeed valve.

51-Center Tank FUEL PUMP LOW PRESSURE Lights (AMBER) EXTINGUISHED: * Pump output pressure is NORMAL, or *

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Pump switch is OFF ILLUMINATED: * Pump switch is ON and output pressure is LOW NOTE: when the center tank pump switches are OFF, their LOW PRESSURE lights are EXTINGUISHED. When main tank pump switches are OFF, their LOW PRESSURE lights are ILLUMINATED CENTER TANK LEFT AND RIGHT FUEL PUMP SWITCHES: ON * Activates fuel pump OFF * Deactivates fuel pump When both fuel pump LOW PRESSURE lights illuminate for the same main tank, the MASTER CAUTION and FUEL system annunciator lights on the glareshield also illuminate. Illumination of a SINGLE fuel pump LOW PRESSURE light causes the MASTER CAUTION and FUEL system annunciator lights to illuminate during a recall.

FUEL PANEL CONTROLS AND INDICATIONS REVIEW

52-MAIN TANK FUEL PUMP LOW PRESSURE LIGHTS (AMBER) EXTINGUISHED * Pump output pressure is NORMAL. ILLUMINATED * Pump output pressure is LOW, or * Pump switch is OFF. MAIN TANKS AFT AND FORWARD FUEL PUMP SWITCHES ON * Activates fuel pump. OFF * Deactivates fuel pump.

53-CROSSFEED VALVE OPEN LIGHT (BLUE) EXTINGUISHED * Crossfeed valve is CLOSED. ILLUMINATED (BRIGHT): * Crossfeed valve is in transit, or * Crossfeed valve is not in commanded position. ILLUMINATED (DIM): * Crossfeed valve is OPEN. CROSSFEED SELECTOR Controls fuel crossfeed valve. Closed * Disconnects engine No. 1 and No. 2 fuel manifolds. Open * Connects engine No. 1 and No. 2 fuel manifolds.

54-ENGINE VALVE CLOSED AND SPAR VALVE CLOSED LIGHTS (BLUE) EXTINGUISHED * Valve is OPEN. ILLUMINATED (BRIGHT) * Valve is in transit, or * Valve is not in the commanded position. ILLUMINATED (DIM) * Valve is CLOSED.

55-FUEL FILTER BYPASS LIGHTS (AMBER) EXTINGUISHED * Filter is functioning normally. ILLUMINATED * Filter becomes clogged. Fuel is about to bypass the filter and unfiltered fuel is to be supplied to respective engine.

56-FUEL TEMPERATURE (TEMP) INDICATOR * Shows the fuel temperature.

COURSE END

57-End of the course.