CL-350

CL-350 TRAINING MANUAL

FUEL 03

AIRCRAFT SYSTEMS

TRAINING MANUAL

LOFT.AERO

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FUEL

I. INTRODUCTION

The Challenger 350 fuel system represents a sophisticated, dual-redundant architecture designed to provide reliable fuel delivery to the aircraft's twin engines and auxiliary power unit while maintaining operational safety and efficiency throughout the flight envelope. Built around integral wet wing tanks with fuel-resistant sealant construction, the system utilizes collector tanks located in the aft section of each wing as the primary fuel source for all engine consumption.

The design employs two independent distribution systems—left feeding the left engine and right feeding both the right engine and APU—with primary fuel delivery accomplished through engine-driven ejectors using high-pressure motive flow for optimal efficiency. Redundancy is provided through electric DC boost pumps that automatically activate during engine start or ejector failure, while a dual-channel fuel computer continuously monitors system parameters and controls refueling operations.

The system incorporates multiple safety features including flapper check valves to prevent fuel flow during aircraft maneuvers, comprehensive water drainage systems, NACA scoop venting for pressure equalization, and strategically located fuel shutoff valves that integrate with the aircraft's fire protection systems.

This chapter will examine each component of this integrated fuel management system, detailing normal operations, emergency procedures, and the EICAS-driven monitoring that enables crews to maintain situational awareness of fuel distribution, quantity, and system health throughout all phases of flight.

A. FUEL TANK CAPACITIES

Pressure Refuel

Parameter	Value
Right Tank	7,075 lb
Left Tank	7,075 lb
Total Capacity	14,150 lb

Gravity Refuel (Airplane Level)

Parameter	Value
Right Tank	6,500 lb
Left Tank	6,500 lb
Total Capacity	13,000 lb

NOTE: Based on fuel density of 6.75 lb/USG. Fuel mass provided for reference only.

B. SYSTEM DESCRIPTION

- Two separate fuel distribution systems
- Left system feeds left engine
- Right system feeds right engine and APU
- All fuel flows through collector tanks
- Single-point and overwing refueling capability
- Underwing water drains for contamination removal
- Low drag NACA vent scoops for static venting

C. APPROVED FUELS

American Specifications:

- ASTM D1655 (Kerosene Type: Jet A, Jet A-1; Wide-Cut Type: Jet B)
- MIL-DTL-5624 (Kerosene Type: JP-5; Wide-Cut Type: JP-4)
- MIL-DTL-83133 (Kerosene Type: JP-8)

Canadian Specifications:

- CAN/CGSB 3.23-97 (Kerosene Type: Jet A, Jet A-1)
- CAN/CGSB 3.22-97 (Wide-Cut Type: Jet B, JP-4)
- 3-GP-24c (Kerosene Type: JP-5)

British Specifications:

- Def-Stan 91-91/3 (Kerosene Type: Jet A, Jet A-1)
- Def-Stan 91-86/2 (Kerosene Type: JP-5)
- Def-Stan 91-87 (Kerosene Type: JP-8)
- Def-Stan 91-88/1 (Wide-Cut Type: Jet B, JP-4)

Russian/Ukrainian Specifications:

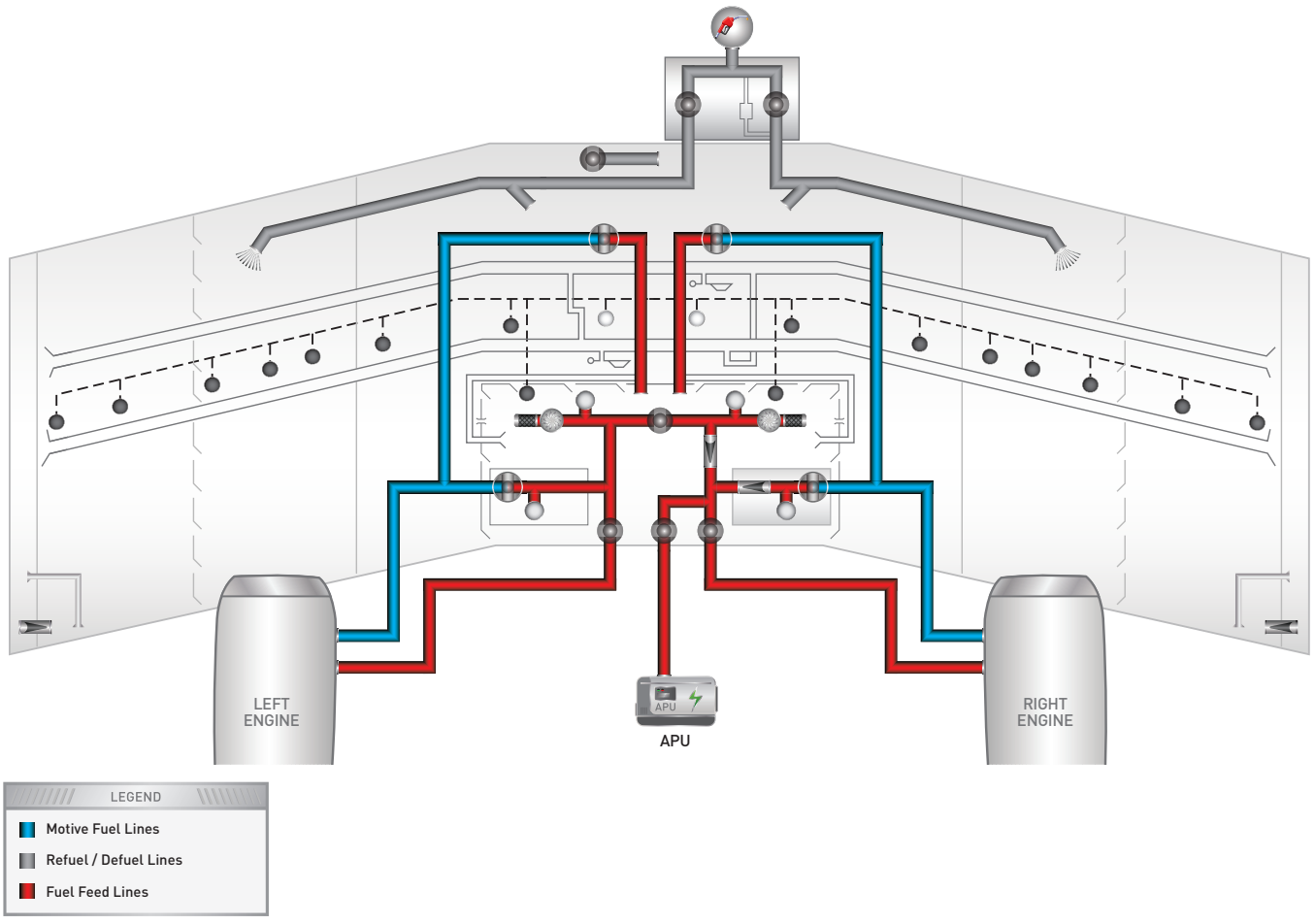
- TS-1 & RT

Chinese Specifications:

- GB 6537-2006 No. 3 JET

Note: Approved fuel additives include: Prist (MIL-DTL-27686), Methyl cellosolve, Biobor JF biocide (270 ppm), STADIS 450 (anti-static) and multiple corrosion inhibitors (check AFM)

FUEL SYSTEM SCHEMATICS



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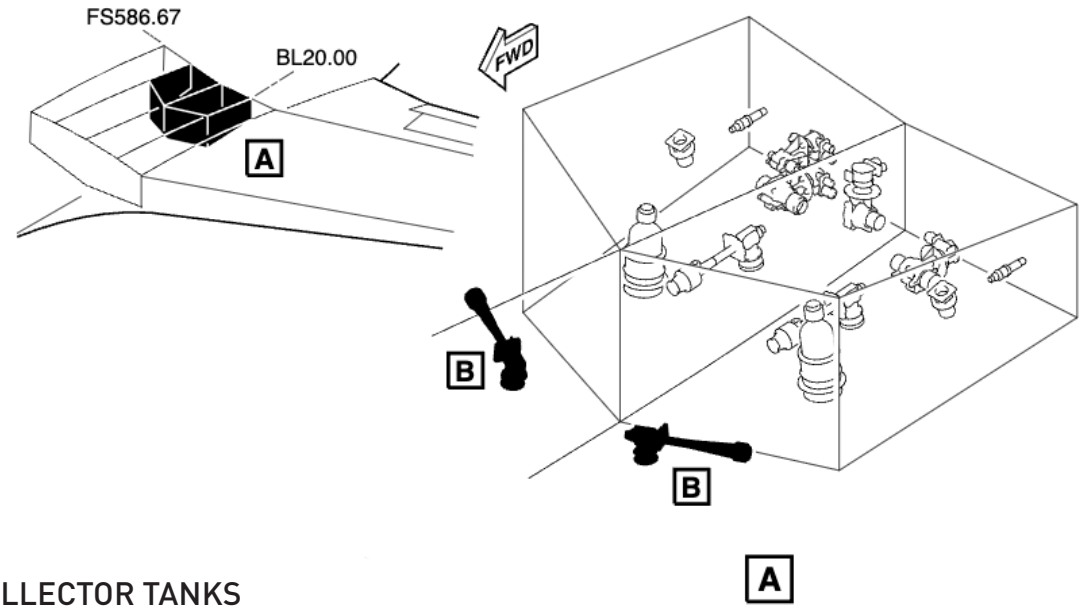
II. FUEL TANK SYSTEM

A. TANK CONSTRUCTION

- Integral type fuel tanks
- Wet wing design
- Sealed with fuel-resistant sealant



A

B. COLLECTOR TANKS

- Aft section of each wing tank
- Rear inboard corner of wing

Fuel Supply:

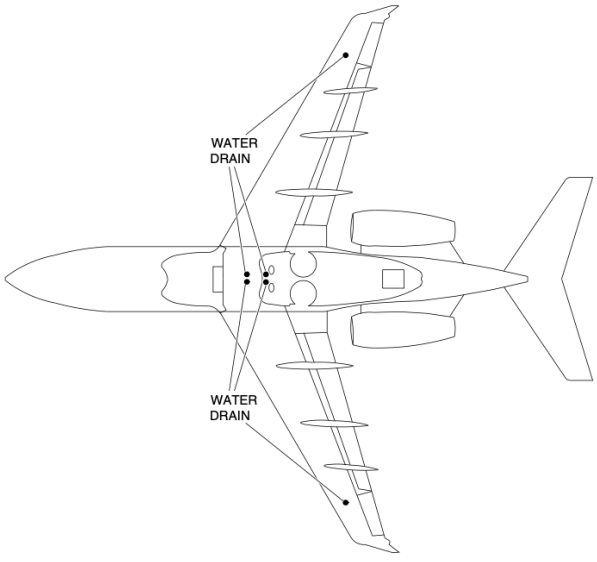
- Gravity flow through flapper check valves
- Scavenge ejectors (when engines operating)
- All engine fuel consumption from collector tanks

C. WATER DRAIN VALVES

- Three valves per wing
- One for collector tank
- One for wing tank
- One for surge tank (outboard area)

Function:

- Drain water and contaminants
- Complete fuel removal during defueling
- Drain until fuel clear if contamination suspected



D. FLAPPER CHECK VALVES

- Attached to internal wing ribs
- Prevent outward fuel flow during aircraft maneuvers

E. VENT SYSTEM

NACA Scoops:

- Located on lower wing trailing edge surfaces
- One per wing
- Low drag vents
- Provide static ventilation
- Relieve air pressure differential

Surge Bays:

- Located outboard of wing tanks
- Hold 53.6 lb fuel each
- Additional expansion volume
- Prevent fuel spillage
- Flapper valves prevent outward fuel flow

III. FUEL DISTRIBUTION

A. ENGINE FUEL FEED

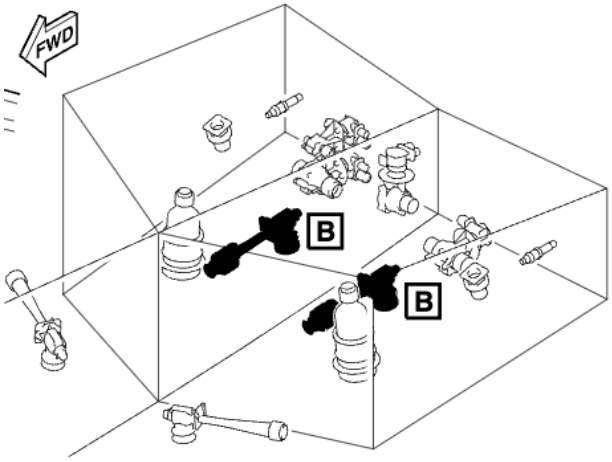
- Independent from respective tank
- Pressurized by ejector using engine motive flow
- High pressure fuel to ejector nozzle
- Same source drives scavenge ejector
- Self-energized by respective engine
- Pressure switch at ejector outlet signals proper operation

B. APU FUEL FEED

- Right collector tank to APU
- Right main ejector (primary)
- Right DC fuel pump (if ejector pressure low)
- APU shutoff valve included

C. MAIN EJECTORS

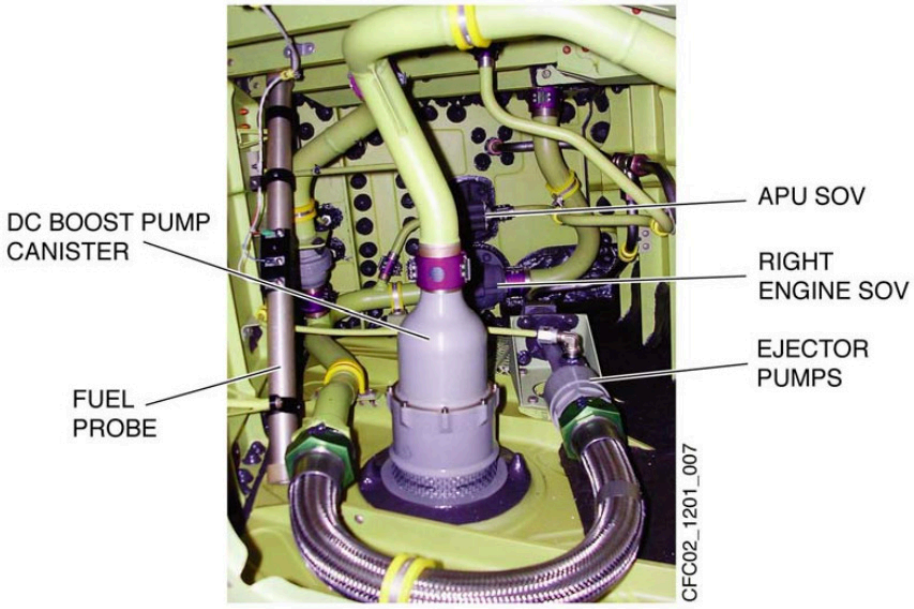
- Motive flow from engine-driven fuel pumps
- High-pressure output operation
- Take fuel from collector tanks
- Deliver fuel to engines
- Installed on bottom of collector tanks



Primary Ejector Pump Location

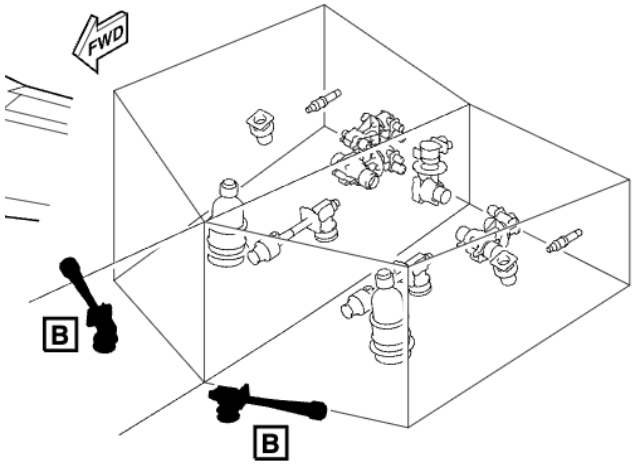
D. MOTIVE FLOW OPERATION

- Engine-driven pump provides motive flow pressure
- High-pressure flow passes through ejector venturi
- Increased fluid velocity creates low pressure
- Suction moves fuel from tank



E. SCAVENGE EJECTORS

- Lowest inboard point of each wing tank
- Motive flow from engine-driven fuel pumps
- Transfer fuel from wing tanks to collector tanks



Scavenge Ejector Pump Location

F. ELECTRIC FUEL PUMPS (DC BOOST PUMPS)

Primary Functions:

- Fuel pressure during engine start
- Backup for main ejector pump failure
- Fuel transfer between wing tanks

Operation:

- Parallel with each feed ejector
- AUTO mode: ON when ENGINE RUN switch ON and boost pump armed
- Operates when feed ejector insufficient pressure
- 10-second time delay after ejector pressure achieved

G. CROSSFLOW SYSTEMS

1. **Powered Transfer System**

   Components:

   - DC boost pumps
   - Transfer valve (interconnects pumps)
   - Manual pilot control

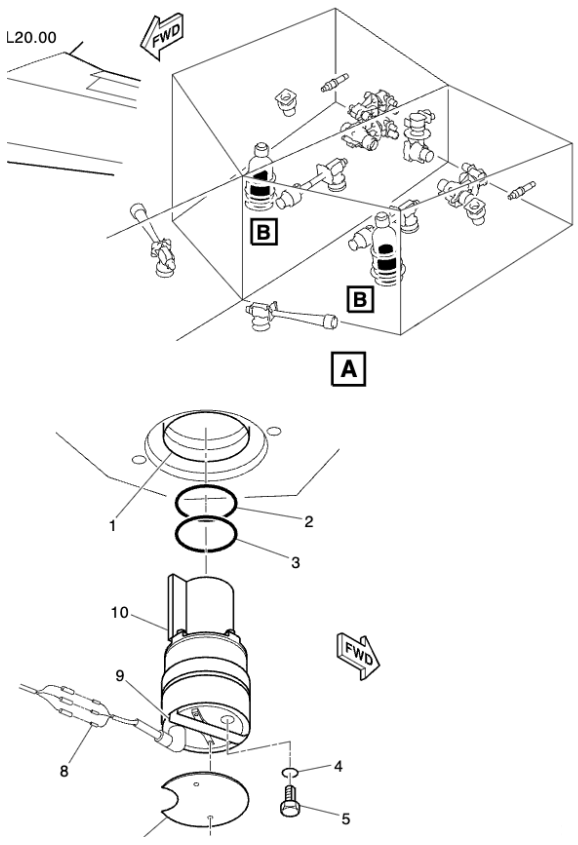
   Operation:

   - Transfer valve normally closed (isolates L/R systems)
   - Open transfer valve for fuel transfer
   - Switch ON DC boost pump
   - Fuel pumped through transfer valve and inactive pump
   - Visual monitoring via EICAS

2. **Gravity Crossflow System**

   Operation:

   - Independent of pumped system
   - Direct flow path between wings
   - Gravity crossflow shutoff valve control
   - Aircraft maneuvering may be required for minimal imbalance
   - Large imbalance requires no maneuvering

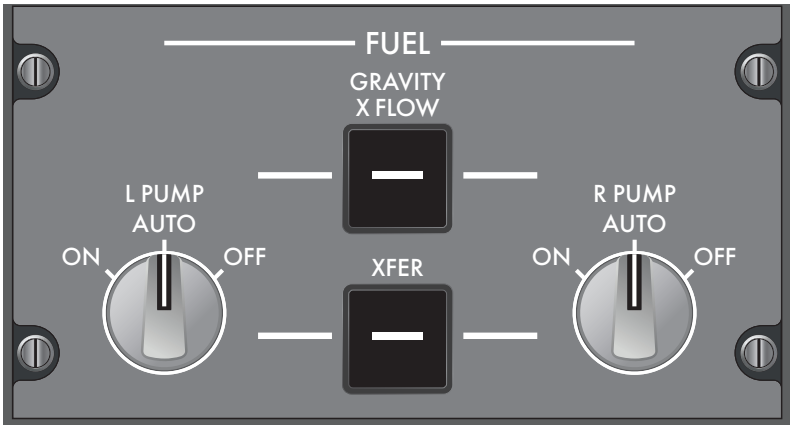


DC Boost Pump

IV. CONTROLS AND INDICATION

A. FUEL CONTROL PANEL

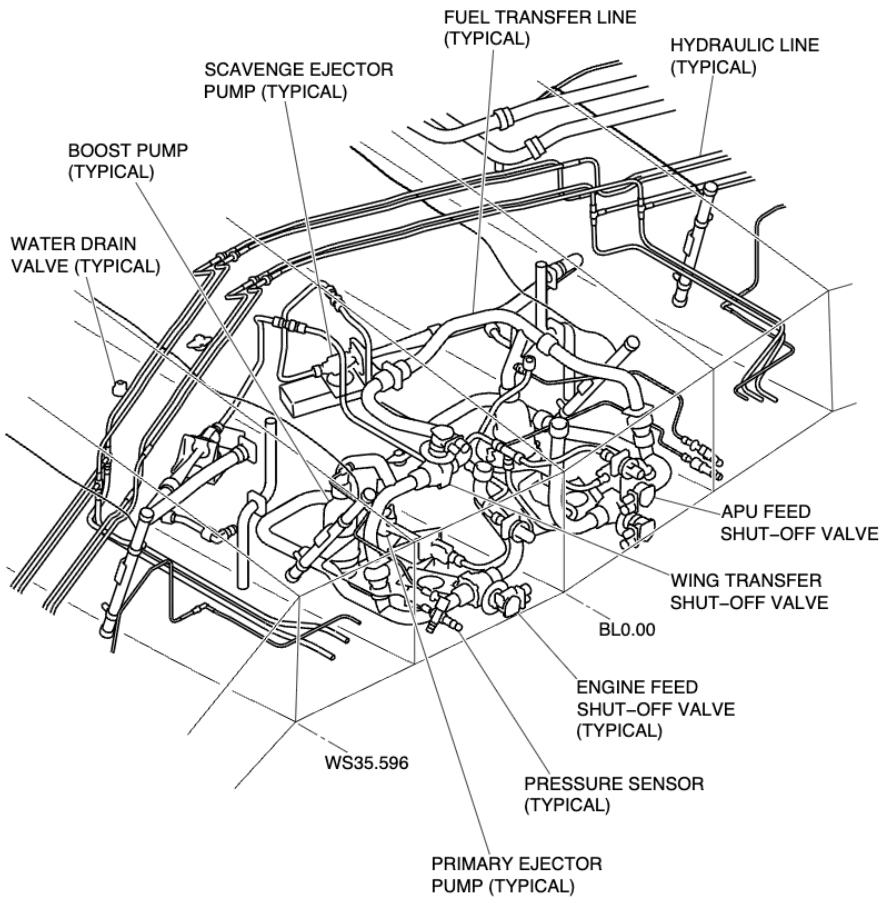
- L PUMP and R PUMP switches
- (OFF, AUTO, ON)
- XFER SWITCH
- GRAVITY XFLOW switch
- L (R) ENG FIRE switches



B. BOOST PUMP CONTROL

AUTO Mode Operation:

- ENGINE RUN switch ON
- Boost pump armed
- Operates when ejector insufficient pressure
- 10-second delay after ejector pressure achieved



Fuel Component Locations

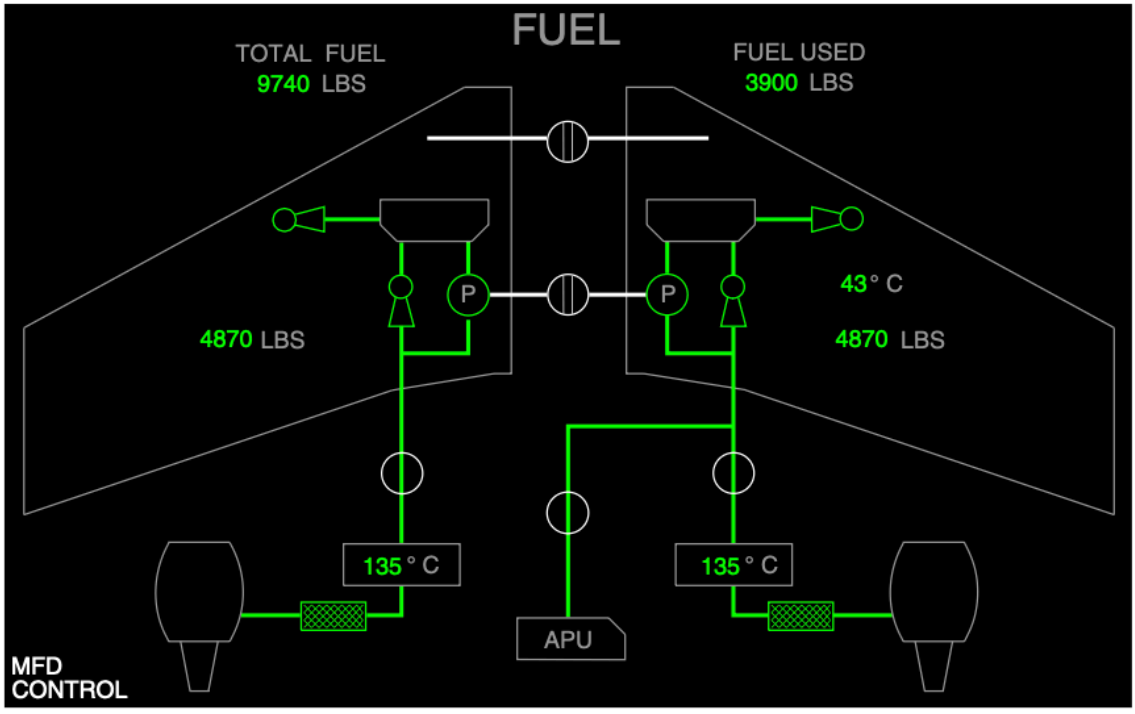
C. FUEL DISPLAY

FUEL Synoptic Page:

- Digital fuel flow indications
- Fuel quantity displays
- Flow: PPH or KPH units
- Quantity: pounds or kilograms
- Magenta dashes indicate invalid input

D. FUEL TEMPERATURE READOUTS

- Bulk Fuel Temperature:
- Right wing tank indication
- Green: Above –35°C (–31°F)
- **WING FUEL TEMP LOW** (C) message below –35°C (–31°F)



E. FUEL QUANTITY INDICATIONS

TOTAL FUEL:

- Green digits: Over 1,000 lb total and 500 lb per wing

FUEL IMBALANCE (C) Message Triggers:

- 250 lb imbalance with total fuel > 13,700 lb
- 315 lb imbalance with total fuel 10,000-13,700 lb
- 450 lb imbalance with total fuel 4,700-10,000 lb
- 600 lb imbalance with total fuel < 4,700 lb

FUEL USED:

- Amount since counter reset
- Automatic reset on FADEC power-up
- Magenta dashes indicate invalid data

V. FUEL QUANTITY GAGING

A. FUEL COMPUTER

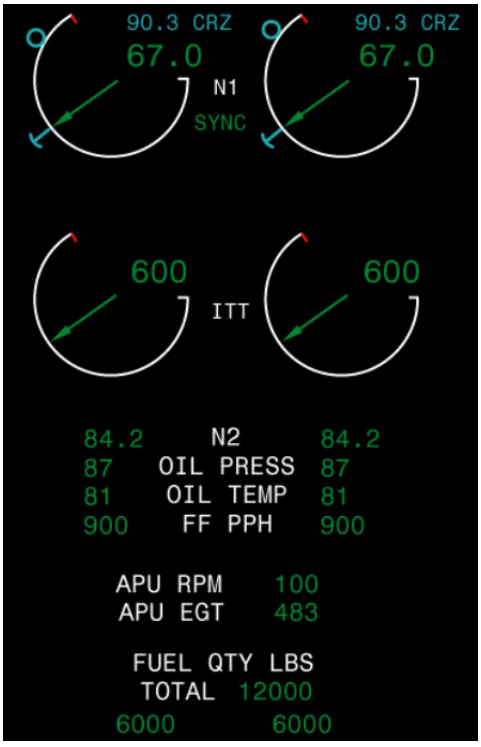
- Dual-channel fuel system computer
- Calculate onboard fuel quantity
- Control refueling operations
- One channel per side
- Automatic switchover if channel fails
- Receives signals from probes and IRS

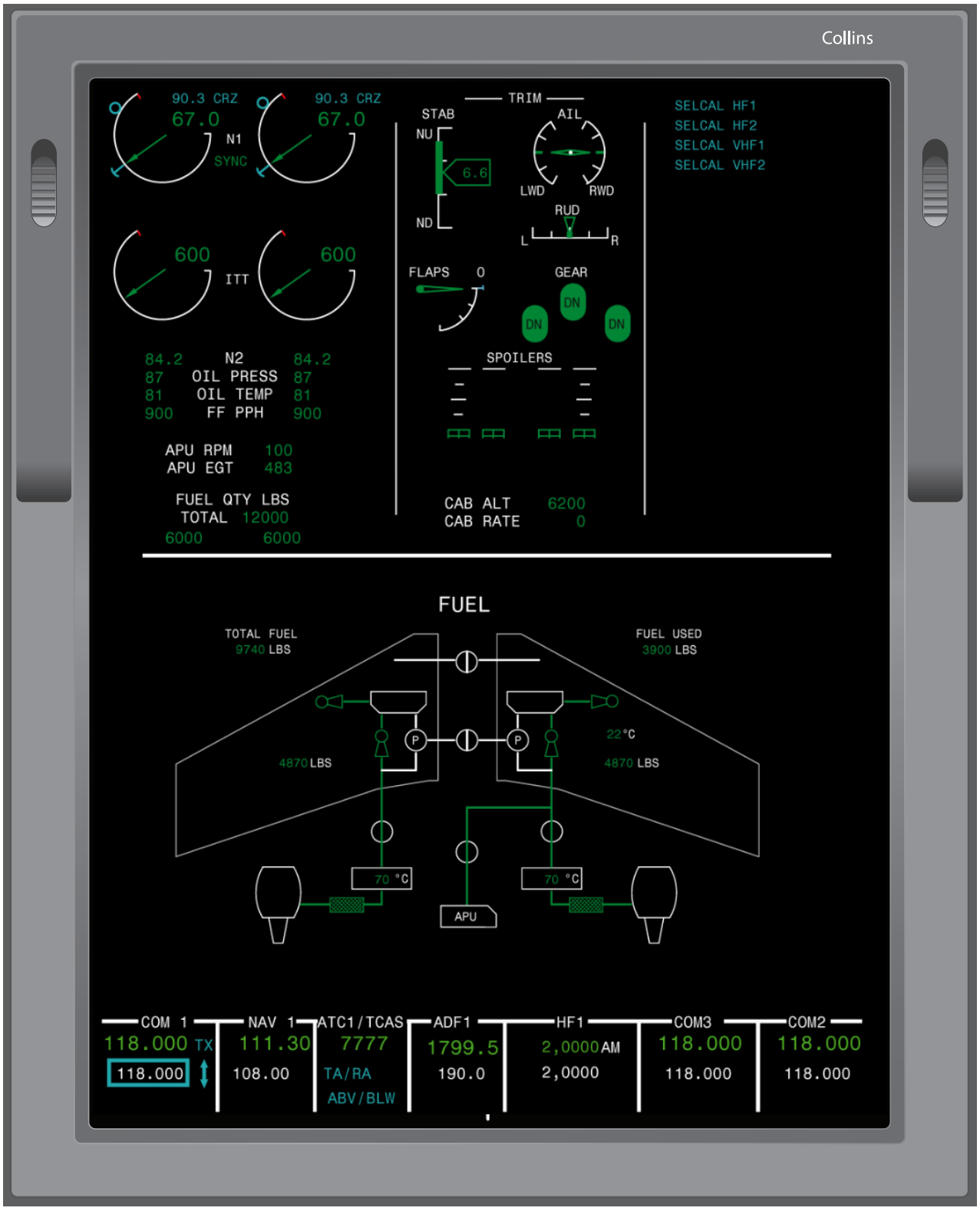
Calculation Inputs:

- Fuel density
- Fuel probe readings
- Aircraft attitude and accelerations
- Weight-on-wheels (WOW) signal

B. FUEL QUANTITY GAGING COMPUTER

- Fuel quantity probe signal processing
- Fuel density probe processing
- Fuel level and temperature processing
- Sensor signal processing
- Weight-off-wheels and attitude correction from IRS
- Accurate fuel quantity display on EFIS
- Failure monitoring and EICAS indication
- Maintenance diagnostic computer communication
- Automatic refueling/defueling control
- Engine oil level indication to refuel/defuel panel

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67.0
N1
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90.3 CRZ
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600
ITT
600
84.2 N2 84.2
87 OIL PRESS 87
81 OIL TEMP 81
900 FF PPH 900
APU RPM 100
APU EGT 483
FUEL QTY LBS
TOTAL 12000
6000 6000
TRIM
STAB
NU
6.6
ND
AIL
LWD
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L
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FLAPS 0
GEAR
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SPOILERS
CAB ALT 6200
CAB RATE 0
SELCAL HF1
SELCAL HF2
SELCAL VHF1
SELCAL VHF2
FUEL
TOTAL FUEL
9740 LBS
FUEL USED
3900 LBS
4870 LBS
22 °C
4870 LBS
70 °C
70 °C
APU
COM 1
118.000 TX
118.000
NAV 1
111.30
108.00
ATC1/TCAS
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TA/RA
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ADF1
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C. FUEL TEMPERATURE PROBE

- Located in right wing tank
- Provides temperature information to fuel indicating system

D. FUEL LEVEL SENSORS

- Tank full sensor at top of each tank
- Cutoff signal to refuel valve when tank full

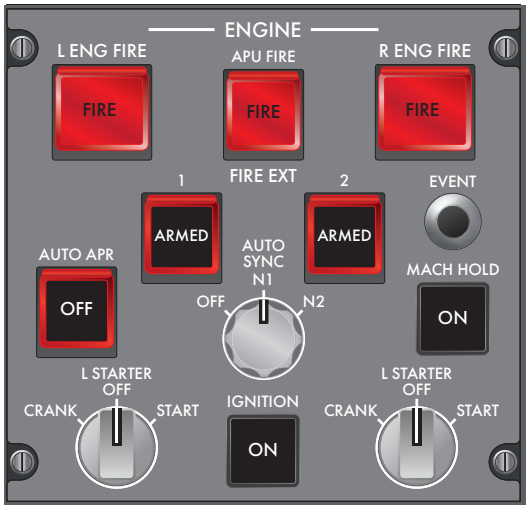
VI. ENGINE FUEL SHUTOFF VALVES

A. ENGINE FUEL SHUTOFF VALVE (SOV)

- Aft spar of wing box in main landing gear bay
- Controlled by the L (R) ENG FIRE switches on ENGINE control panel
- Electrically operated valves
- Stop fuel flow to engines
- Located forward of engine rotor burst areas
- Close on ENG FIRE switch activation
- Can be reopened by pushing switches again

B. APU FUEL FEED SHUTOFF VALVE (SOV)

- Electrically operated shutoff valve
- APU FIRE switch on ENGINE control panel
- Automatic control during normal operations



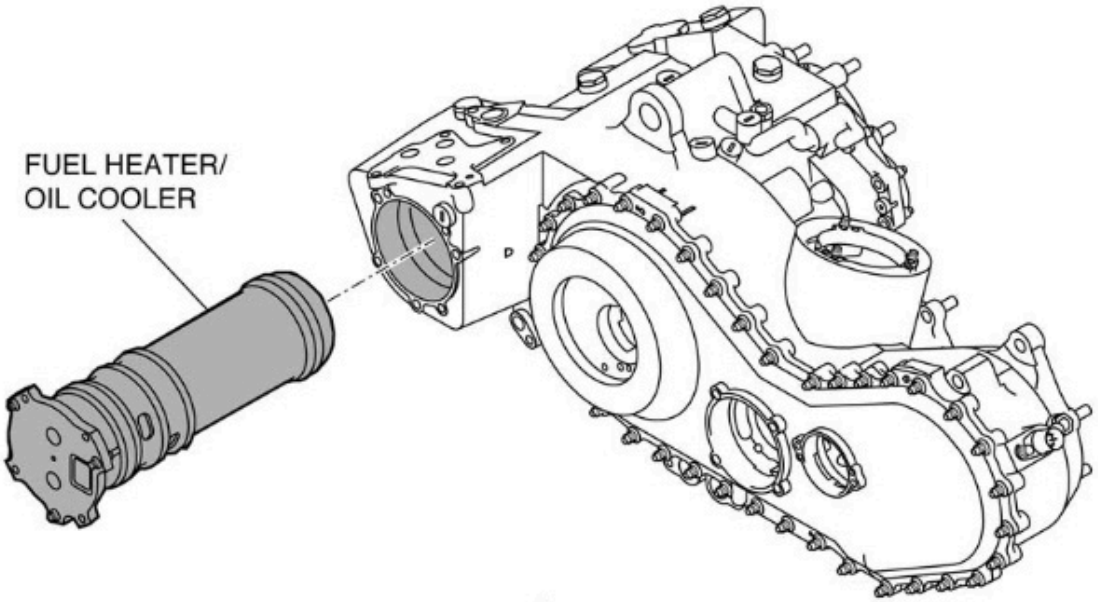
VII. FUEL FILTERING AND HEATING

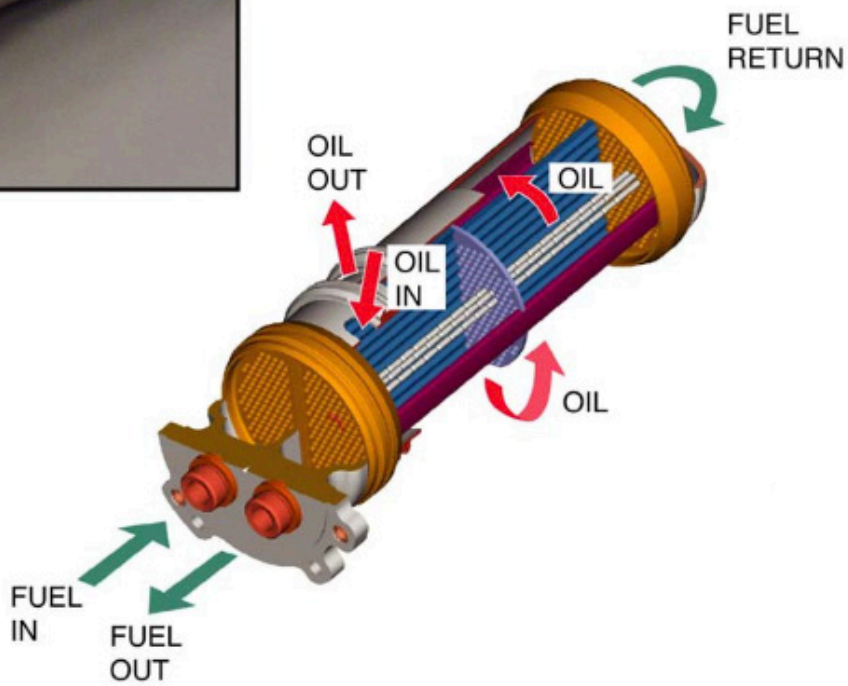
A. FUEL HEATER/OIL COOLER (FHOC)

- Located in the engine accessory gearbox (AGB)
- Heat fuel to prevent ice formation in engine fuel system
- Maintain engine oil temperature within limits

B. FUEL FILTER

- Just aft of oil tank on engine
- Impending bypass switch monitors contamination
- EICAS signal when fuel pressure parameters exceeded


FUEL HEATER/
OIL COOLER


FUEL
RETURN
OIL
OUT
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OIL
FUEL
IN
FUEL
OUT

VIII. REFUELING/DEFUELING

A. REFUELING METHODS

- **Pressure Refueling:** Preferred method – 14,150lbs max
    - Limited to 55 psig
- **Gravity Refueling:** When single-point unavailable – 13,000lbs max

B. DEFUELING

- Suction defueling – limited to -8 psig
- Single-point refuel/defuel adapter
- Refuel/defuel control panel configuration
- Maintenance personnel function only

Single Point Fueling Port

C. REFUEL/DEFUEL CONTROL PANEL

Right wing root leading-edge fairing

- Preselected total fuel load
- Automatic computer control
- Manual control option
- High-level sensor prevents overfilling
- Simulated high-level sensor test capability

D. FUEL COMPUTER CONTROL

- Dual-channel system monitors refueling process
- Controls refueling operations

Remote Oil / Fuel Panel

IX. EICAS MESSAGES

A. WARNING MESSAGES

None.

B. CAUTION MESSAGES

CAUTION MESSAGES

Timely crew awareness/action needed

Message	Meaning	Inhibits
L (R) FUEL COLLECTOR LOW	The fuel collector tank quantity is less than 200 pounds	—
L (R) FUEL EJECTOR FAIL	The affected ejector pump has failed to provide sufficient pressure.	TO/LAND
L (R) ENG FUEL SOV FAIL	The respective engine fuel shutoff valve has failed to close when commanded	TO/LAND
FUEL IMBALANCE	The wing fuel imbalance is greater than: 250 lb with total fuel > 13,700 lb; 315 lb with total fuel 10,000-13,700 lb; 450 lb with total fuel 4,700-10,000 lb; 600 lb with total fuel < 4,700 lb	TO/LAND
L (R) FUEL PRESSURE LOW	The engine fuel pressure is below 6 psi (Maintain 18,500' or below for suction feed)	TO/LAND
L (R) FUEL PUMP FAIL	The respective electric fuel pump has failed	TO/LAND
FUEL QUANTITY FAIL	Both channels of the fuel quantity gauging computer have failed. fuel quantities will be indicated as magenta dashes on the EICAS	TO/LAND
FUEL QUANTITY LOW	Fuel quantity is 300 lbs or less in one or both wings.	TO
WING FUEL TEMP LOW	Fuel temperature in the wing is below –35°C (–31°F)	TO/LAND

C. ADVISORY MESSAGES

ADVISORY MESSAGES

Crew awareness - no immediate action required

Message	Meaning	Inhibits
FUEL GRAV XFLOW FAIL	The wing fuel gravity crossflow valve is not fully opened or closed as commanded	TO/LAND
L (R) FUEL PUMP ON	Indicated electrical fuel pump is on	TO/LAND
FUEL QUANTITY FAULT	The left or right channel has detected a fault or loss of temperature compensation	TO/LAND
FUEL XFER FAIL	The fuel transfer valve has failed	TO/LAND

D. STATUS MESSAGES

STATUS MESSAGES	
Information only - no crew action required	
Message	**Meaning**
L (R) ENG FUEL SOV CLSD	Respective engine fuel shutoff valve is closed
FUEL BALANCED	The fuel is balanced within 100 lb with the FUEL XFER valve open
FUEL GRAV XFLOW OPEN	Wing fuel gravity crossflow valve is open
L (R) FUEL PUMP OFF	The respective fuel pump is OFF
L (R) FUEL PUMP ON	The respective fuel pump is ON
FUEL XFER OPEN	The fuel transfer valve is open

NOTES

- All warning messages are accompanied by a triple chime
- All caution messages are accompanied by a single chime
- "TO/LAND" indicates the message in inhibited during takeoff and landing phases
- "TO" indicates the message in inhibited during takeoff only
- L (R) notation indicates the message can appear for either left or right engine/system
- Fuel imbalance thresholds vary based on total fuel weight to account for aircraft balance sensitivity

X. LIMITATIONS

A. FUEL CAPACITY LIMITATIONS

Pressure Refuel

Parameter	Value
Right Tank	7,075 lb
Left Tank	7,075 lb
Total Capacity	14,150 lb

Gravity Refuel (Airplane Level)

Parameter	Value
Right Tank	6,500 lb
Left Tank	6,500 lb
Total Capacity	13,000 lb

NOTE: Based on fuel density of 6.75 lb/USG. Fuel mass provided for reference only.

B. FUEL IMBALANCE LIMITATIONS

Total Fuel Quantity	Maximum Imbalance
Total fuel > 13,700 lb	250 lb
Total fuel 10,000-13,700 lb	315 lb
Total fuel 4,700-10,000 lb	450 lb
Total fuel < 4,700 lb	600 lb

C. FUEL TEMPERATURE LIMITATIONS

Minimum Fuel Temperature by Fuel Type:

Fuel Type	Minimum Temperature
Jet A	-30°C (-22°F)
Jet A-1	-35°C (-31°F)
JP-5	-35°C (-31°F)
JP-8	-35°C (-31°F)
Jet B	-40°C (-40°F) (Max altitude 16,000')
JP-4	-40°C (-40°F) (Max altitude 16,000')

Minimum Fuel Temperature by Fuel Type:

Fuel Type	Minimum Temperature
Russian TS-1	-35°C (-31°F) (Max altitude 37,000' if bulk temp > 35°C (86°F))
Russian RT	-40°C (-40°F) (-31°F) (Max altitude 37,000' if bulk temp > 35°C (86°F))
Ukrainian TS-1 & RT	-40°C (-40°F) (-31°F) (Max altitude 37,000' if bulk temp > 35°C (86°F))
GB 6537-2006 No. 3 JET	-37°C (-34.6°F)

NOTES

- Takeoff is prohibited if bulk fuel temperature indications are above 50°C (122°F)
- When wing bulk fuel temperature is 45°C (113°F) or above, the following limitations apply:
  - Minimum fuel load for takeoff is 2,800 lbs
  - If there is less than 1,000 lbs per side, engine operation is limited to a maximum of 30 minutes.
  - Minimum fuel quantity for a go-around: 500 lbs per side

XI. FUEL SYSTEM CIRCUIT BREAKERS

Fuel System Circuit Breakers

CB Name	Bus	Location
FUEL PUMP L	LEFT ESS	CB1-F1
FUEL PUMP R	RIGHT ESS	CB2-F1
FUEL XFER L	LEFT MAIN	CB3-F2
FUEL XFER R	RIGHT MAIN	CB4-F2
FUEL QUANTITY L	LEFT ESS	CB1-F3
FUEL QUANTITY R	RIGHT ESS	CB2-F3
FUEL CONTROL L	LEFT ESS	CB1-F4
FUEL CONTROL R	RIGHT ESS	CB2-F4
REFUEL CONTROL	RIGHT MAIN	CB4-F5
FUEL SHUTOFF L	LEFT ESS	CB1-F6
FUEL SHUTOFF R	RIGHT ESS	CB2-F6
FUEL TEMP	LEFT MAIN	CB3-F7
FUEL FILTER BYPASS	RIGHT MAIN	CB4-F8

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XII. FUEL SYSTEMS QUIZ

1. What is the maximum usable fuel capacity for pressure refueling?

    A. 13,000 lb
    B. 14,150 lb
    C. 15,000 lb
    D. 7,075 lb

2. Where are the collector tanks located?

    A. Forward section of each wing tank
    B. Center section of each wing tank
    C. Aft section of each wing tank
    D. Outside the wing tanks

3. How many water drain valves are in each wing?

    A. Two
    B. Three
    C. Four
    D. Five

4. What provides motive flow for the ejectors?

    A. Electric pumps
    B. Engine-driven fuel pumps
    C. APU-driven pumps
    D. Gravity feed

5. The scavenge ejectors are located at:

    A. The highest point of each wing tank
    B. The center of each wing tank
    C. The lowest inboard point of each wing tank
    D. The outboard area of each wing tank

6. How much fuel does each surge bay hold?

    A. 50.0 lb
    B. 53.6 lb
    C. 60.0 lb
    D. 75.0 lb

7. What is the minimum fuel temperature before a CAS message appears?

    A. –30°C (–22°F)
    B. –35°C (–31°F)
    C. –40°C (–40°F)
    D. –45°C (–49°F)

8. The fuel quantity gaging computer uses all of the following EXCEPT:

A. Fuel density
B. Aircraft attitude from IRS
C. Weight-on-wheels signal
D. Engine oil temperature

9. Where are the engine fuel shutoff valves located?

A. In the engine accessory gearbox
B. On the wing leading edge
C. On the aft spar of the wing box in the main landing gear bay
D. In the collector tanks

10. The time delay for boost pump operation after ejector pressure is achieved is:

A. 10 seconds
B. 15 seconds
C. 20 seconds
D. 30 seconds

11. Which fuel tank provides fuel to the APU?

A. Left tank only
B. Right tank only
C. Both tanks equally
D. Either tank as selected

12. The FUEL IMBALANCE (C). message appears when there is a 450 lb imbalance with total fuel between:

A. 13,700-10,000 lb
B. 8,000-6,700 lb
C. 10,000-4,700 lb
D. Above 13,700 lb

13. What type of fuel tank construction does the Challenger 350 use?

A. Integral wet wing tanks
B. Bladder tanks
C. Rigid fuel cells
D. External drop tanks

14. The main ejectors are installed:

A. At the top of the collector tanks
B. On the bottom of the collector tanks
C. In the center of the wing tanks
D. On the wing leading edge

15. During gravity crossflow, aircraft maneuvering may be required when:

A. The fuel imbalance is large
B. The aircraft is on the ground
C. Both engines are operating
D. The fuel imbalance is minimal

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