

## SECTION 2-08

### FUEL

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**AIRPLANE  
OPERATIONS  
MANUAL**



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## GENERAL

The EMB-145/135 fuel feed system consists of two independent systems, one for each engine, interconnected by a crossfeed line. The fuel system ensure proper fuel supply to the engines and APU under all the operating conditions.

The system allows refueling and defueling operation to be performed either by pressure or by gravity.

**NOTE:** The fuel weight values present in this manual are based on a fuel density of 0.811 kg/liter (6.767 lb/US Gal).

## FUEL TANKS

The airplane has two fuel tanks, one in each wing. The fuel flows from the wing tip to the wing root by gravity. A collector box in the wing root keeps the electrical pumps inlets submerged. To prevent pumps cavitation, an ejector pump and flap valves ensure enough fuel in the collector box at all conditions.

The fuel tank capacity changes according to airplane model. The EMB-145LR/LU and EMB-135LR models are equipped with a wing stub tank that increases the tank capacity. These airplanes have the collector boxes located in the wing stub.

	<b>TANK CAPACITY</b>			
	Airplanes Without Stub Tank		Airplanes With Stub Tank	
	One Tank	Both Tanks	One Tank	Both tanks
Liters	2573	5146	3198	6396
US gallons	679.8	1359.6	844.9	1689.8
Kilograms	2087	4173	2594	5187
Pounds	4600.2	9200.4	5717.4	11434.9

When performing pressure refueling, the usable fuel quantity in each tank may be reduced by 7.9 US Gal (STD, ER and MP models) or 13.2 US Gal (LR model) maximum.

**NOTE:** When operating with the TS-1 fuel, the FQIS may display a fuel quantity 2% (two percent) higher than the actual fuel loaded in the airplane.

Conversion factors:

- 3.785412 liter/US gallon
- 1.2330456 liter/kg
- 0.4536 kg/lb

## FUEL TANK VENT SYSTEM

The purpose of the fuel vent system is to prevent damage to the wings due to excessive buildup of positive or negative pressures inside the fuel tanks. The system consists of float vent valves, vent lines, a surge box and a NACA air intake. The surge box is located in the wing and it is connected to the fuel tank through two float valves. These valves allow at least one venting point to be open between the surge box and the fuel tank under any flight condition. The surge boxes are connected to outside air through a NACA air intake installed under the wing.

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**ENGINE AND APU FUEL DISTRIBUTION AND CONTROL**

There are three electric pumps for each wing tank that provides pressurized fuel to the engines and APU. One pump is capable to supply fuel for both engines and APU under all phases of flight, except takeoff and go-around.

During takeoff and go-around one electric pump is required for each engine and the APU.

Engine-driven fuel pumps will provide suction feed if the electric fuel pumps operation is not available limited up to a ceiling altitude of 25000 ft.

**NOTE:** Crossfeed Selector Knob must be OFF during takeoff and go-around.

Five knobs located in the overhead fuel panel controls the electric pumps and crossfeed operation. Two PUMP PWR knobs energizes/de-energizes the electric pumps and the other two PUMP SEL knobs selects which pumps will be operating. The remaining pumps will be on standby. If the fuel pressure drops below 6.5 psi, the remaining pumps are automatically switched on and start cycling, until the pilot selects one of them.

The XFEED knob controls the crossfeed operation.

Crossfeed operation should be performed in case of fuel imbalance between tanks. The crossfeed knob acts over the crossfeed valve and over the electric pumps. Selecting the knob to LOW1 or LOW2 will deenergize the pump associated to the side with low level. The crossfeed valve will open connecting the engine 1 and engine 2 fuel feed lines. The fully-opened crossfeed valve position is indicated on the EICAS by an advisory message. In case of valve failure, the EICAS displays a caution message.

**NOTE:** Crossfeed operation does not allow fuel transfer between tanks.



Fuel for APU operation is normally supplied from the right side fuel system. Fuel from the left side system may be used by selecting the crossfeed knob to LOW2. The APU fuel shutoff valve will close in the following conditions:

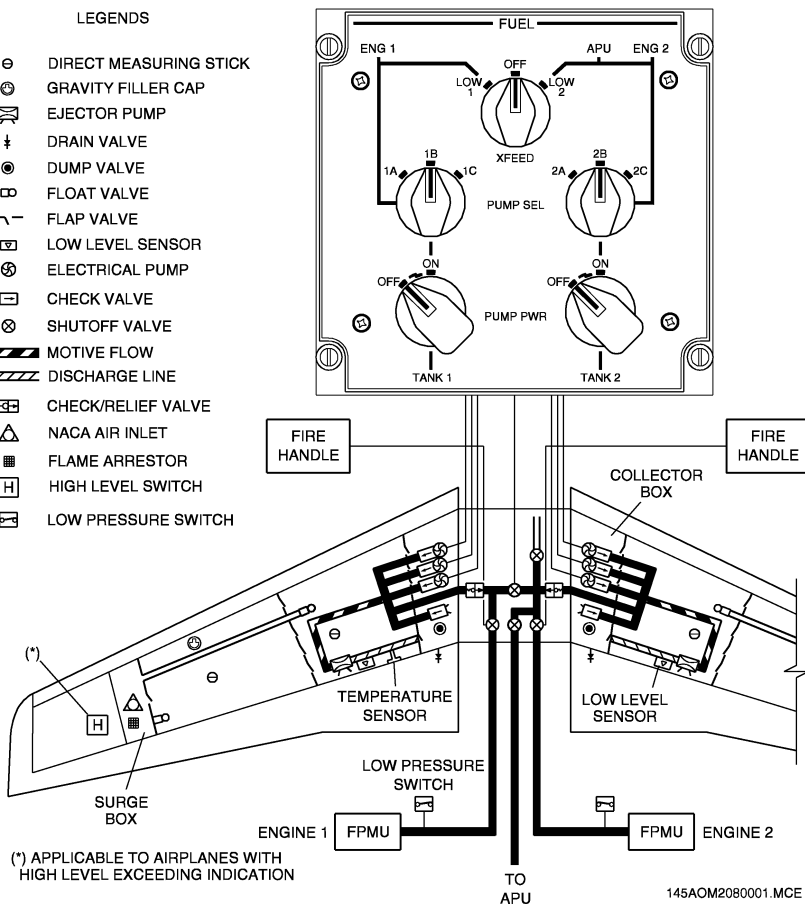
- APU master knob positioned to OFF.
- By pressing the APU fuel shutoff button.
- By pressing the APU fire extinguishing button.
- Automatically, through the APU fire detection system in case of APU fire on ground.

Sensors installed in the tanks and along fuel lines provide signals to indicate system failures and status. Such indications and messages are shown on the MFD Fuel page as well as on the EICAS.

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LEGENDS

- ⊕ DIRECT MEASURING STICK
- ⊙ GRAVITY FILLER CAP
- ☒ EJECTOR PUMP
- ⊥ DRAIN VALVE
- ⊙ DUMP VALVE
- ⊙ FLOAT VALVE
- ∩ FLAP VALVE
- ☒ LOW LEVEL SENSOR
- ⊙ ELECTRICAL PUMP
- ☒ CHECK VALVE
- ⊙ SHUTOFF VALVE
- MOTIVE FLOW
- ▨ DISCHARGE LINE
- ☒ CHECK/RELIEF VALVE
- △ NACA AIR INLET
- FLAME ARRESTOR
- ⊙ HIGH LEVEL SWITCH
- ☒ LOW PRESSURE SWITCH



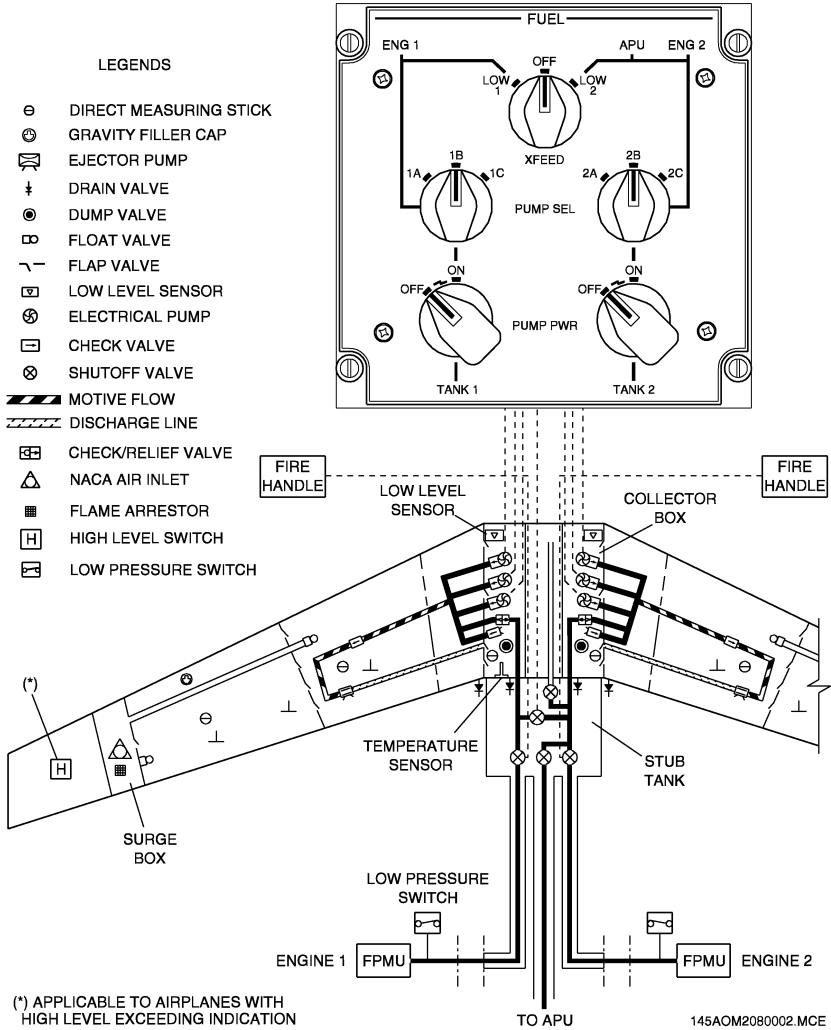
(\*) APPLICABLE TO AIRPLANES WITH HIGH LEVEL EXCEEDING INDICATION

**FUEL SYSTEM SCHEMATIC  
 (AIRPLANES WITHOUT STUB TANK)**

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**FUEL SYSTEM SCHEMATIC  
(AIRPLANES WITH STUB TANK)**



## EICAS MESSAGES

TYPE	MESSAGE	MEANING
WARNING	FUEL 1(2) LO LEVEL	The remaining fuel quantity in the associated tank ranges from 210 kg (463 lb) to 265 kg (584 lb), for leveled flight condition.
	E1 (2) FUEL LO PRESS	Fuel pressure is below 6.5 psi.
CAUTION	FUEL TANK LO TEMP	Fuel temperature inside left tank is at or below $-40^{\circ}\text{C}$ .
	FUEL XFEED FAIL	Disagreement between crossfeed valve and knob position.
	FUEL IMBALANCE	Fuel quantity in one tank differs by 363 kg (800 lb) from the other tank. Message is removed when difference between tanks decreases below 45 kg (100 lb).
	APU FUEL LO PRESS	Fuel pressure is below 6.5 psi with APU operating.
	E1 (2) FUEL SOV INOP	Associated shutoff valve is not in the commanded position.
	APU FUEL SOV INOP	APU shutoff valve is not in the commanded position.
	FUELING DOOR OPN	Refueling panel door is open.
	FUEL EQ XFEED OPN	- Crossfeed valve remains open after fuel imbalance correction - difference between wing tanks fuel quantities lower than 45 kg (100 lb); or - Crew activated the wing fuel imbalance correction to the wing tank with low level.

## EICAS MESSAGES (cont.)

TYPE	MESSAGE	MEANING
ADVISORY	E1 (2) FUEL SOV CLSD	Associated shutoff valve is closed.
	APU FUEL SOV CLSD	APU fuel shutoff valve is closed. Message remains on for 10 seconds after APU Master Knob is set to off. If valve has been commanded to close through APU Fuel Shutoff Button or APU Fire Extinguishing Button the message will remain on continuously.
	FUEL XFEED OPEN	Crossfeed valve is open.

## CONTROLS AND INDICATORS

### FUEL SYSTEM PANEL

#### 1 - CROSSFEED SELECTOR KNOB

- LOW1 – Opens the crossfeed valve and turns off the selected pump of the left wing tank.
- OFF – Closes the crossfeed valve.
- LOW2 – Opens the crossfeed valve and turns off the selected pump of the right wing tank.

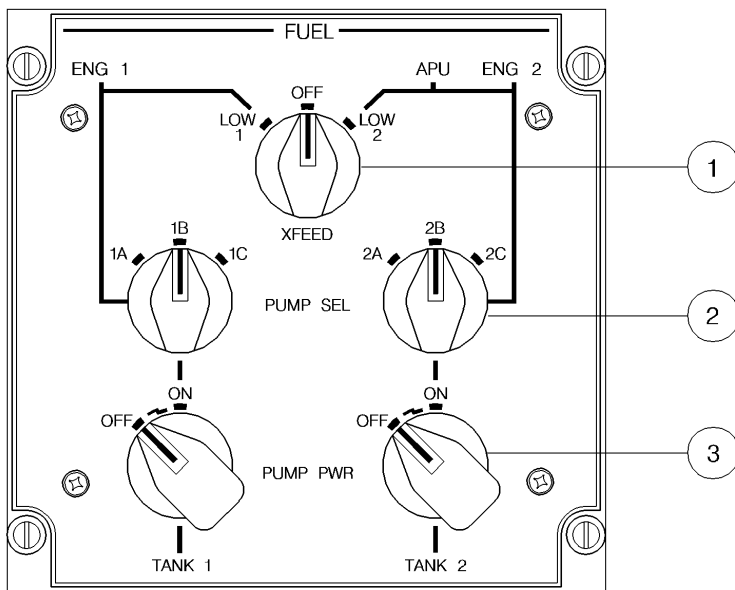
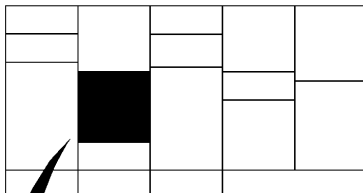
#### 2 - WING TANK FUEL PUMP SELECTOR KNOB

- Selects which electric pump will be operative for each wing tank. The non-selected wing pumps remain as standby.

#### 3 - WING TANK FUEL PUMP POWER KNOB

- ON - Turns ON the selected wing fuel pump.
- OFF - Turns OFF the selected wing fuel pump.

OVERHEAD PANEL



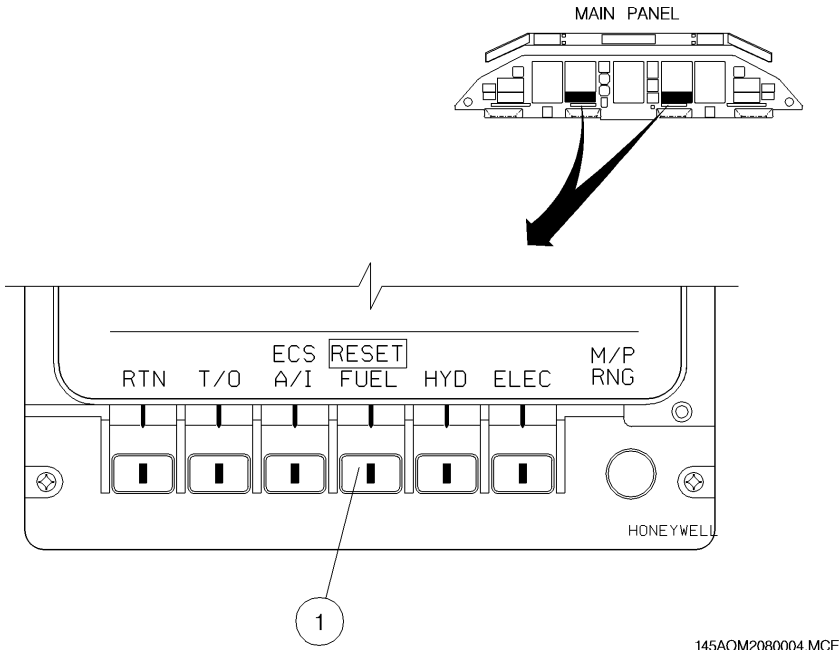
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**FUEL SYSTEM PANEL**

## MFD BEZEL

### 1 - FUEL SYSTEM AND RESET BUTTON

- Pressing FUEL button selects the fuel system page on MFD.  
Pressing the button a second time resets the fuel used to zero.  
Fuel used must be reset individually on each MFD.



## MFD BEZEL



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FUEL

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## FUEL PAGE ON MFD

### 1 - DIGITAL FUEL QUANTITY INDICATION (TANK 1, TANK 2 AND TOTAL)

- The digital fuel tank quantity indicator ranges from 0 to 9990 (for airplanes without stub tank) or from 0 to 15000 (for airplanes with stub tank) with a digital resolution of 10 units, regardless of unit being used (lb or kg), for TANK 1, TANK 2, and TOTAL.
- Colors for each tank identification:
  - Green above 400 kg (880 lb).
  - Amber and boxed from 280 kg to 400 kg (620 lb to 880 lb).
  - Red and boxed below 280 kg (620 lb).
- Colors for TOTAL indication: if TANK1, TANK2 or both fuel quantities enter into red or amber region, total fuel quantity will be boxed (on EICAS and MFD) and displayed in the same color, with the red taking precedence over the amber.

### 2 - ANALOG FUEL QUANTITY INDICATION

- Quantity is indicated by a vertical bar and a pointer. The colors and ranges are the same used for digital fuel quantity indications.

### 3 - DIGITAL FUEL USED INDICATION

- The fuel used indicator ranges from 0 to 9990 (for airplanes without stub tank) or from 0 to 15000 (for airplanes with stub tank) with a digital resolution of 10 units, regardless of unit being used (lb or kg).
- Color: Green under normal operation. Replaced by Amber dashes (in flight) or amber zero (on ground) if any problem is verified.

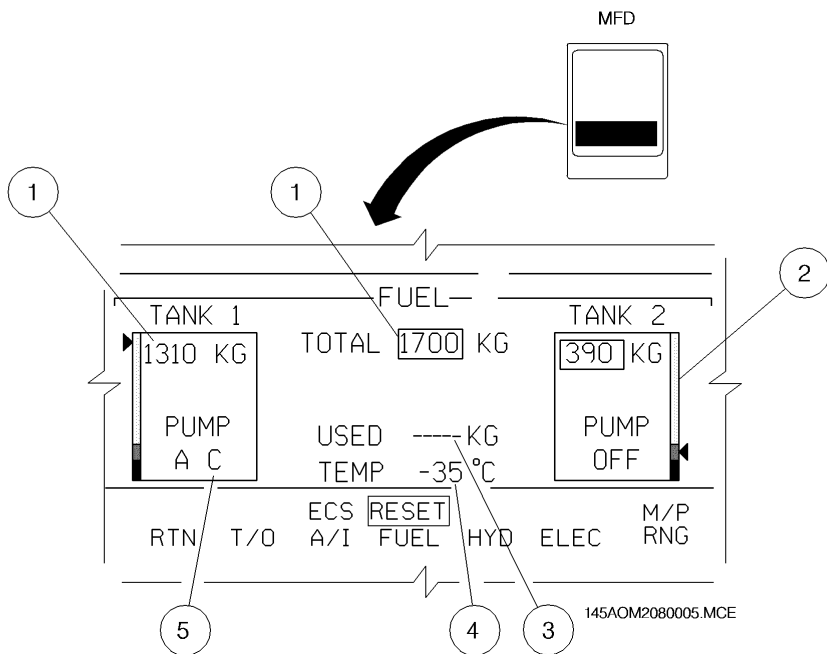
### 4 - DIGITAL FUEL TEMPERATURE INDICATION

- Ranges from  $-60^{\circ}\text{C}$  to  $+60^{\circ}\text{C}$  with a resolution of  $1^{\circ}\text{C}$ .
- Colors:
  - Green above  $-40^{\circ}\text{C}$ .
  - Amber and boxed below  $-40^{\circ}\text{C}$ .

### 5 - OPERATING PUMP INDICATION

- This indicator displays A, B, C or OFF, depending on which pump is selected and whether it is on or off.
- Color: green.
- Wing tank pumps indication may blink when cycling, until the pilot selects another pump.

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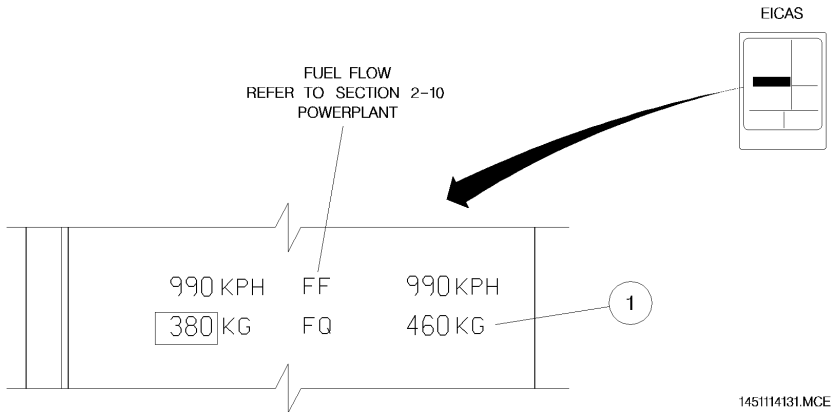


**MFD FUEL PAGE**

## EICAS INDICATIONS

### 1 - FUEL QUANTITY (TANK 1 AND TANK 2) AND FUEL FLOW

- Fuel quantity for each tank and fuel flow for each engine is displayed continuously on EICAS.
- Fuel quantity for each tank:
  - Green above 400 kg (880 lb).
  - Amber and boxed from 280 kg to 400 kg (620 lb to 880 lb).
  - Red and boxed below 280 kg (620 lb).
- Fuel flow for each engine:
  - Ranges from 0 to 2000 kph (or 4000 pph) with a resolution of 5 kph (or 10 pph).
  - Color: Green



## EICAS INDICATIONS



## REFUELING AND DEFUELING

Refueling and defueling operations may be performed either by pressure or by gravity. The refueling panel in the right wing-to-fuselage fairing allows pressurized refueling/defueling operation. A gravity filler cap on the upper skin of each wing allows gravity filling. Dump valves and drain valves are used for gravity defueling.

### PRESSURIZED REFUELING

Pressurized refueling operations require the refueling system being energized. This can be accomplished by either energizing the aircraft through APU, GPU, battery or running engine, selecting the power selection switch to BATTERY.

As fuel pressure is applied on the adapter the two CLOSED lights will illuminate to indicate that refueling shutoff valves are closed. Selecting the refueling switch to OPEN will open the shutoff valves, starting refueling operation. The shutoff valves will close, stopping the refueling operation, when:

- The fuel level in the tanks lifts the associated pilot valve's float. This level defines the maximum fuel volume approved for that tank, through pressure refueling.
- The selected fuel quantity on the refueling panel is achieved.
- The refueling switch is commanded to closed.

For airplanes with High Level Exceeding Indication System incorporated, an automatic refueling shutoff failure will be identified by the HLEIS (High Level Exceeding Indication System), that will sense, via one HLS (High Level Sensor) in each wing tank, that the fuel level in the failed tank reached over the maximum quantity approved for that tank and will advise the operator by illuminating, on the refueling panel, the "STOP RFL" red indicating light of the failed tank. The operator shall interrupt the refueling operation immediately, after viewing the red light on, to prevent fuel spillage through the vent valve and shall call the maintenance personnel to follow the procedure to remove the extra fuel of the associated tank(s).

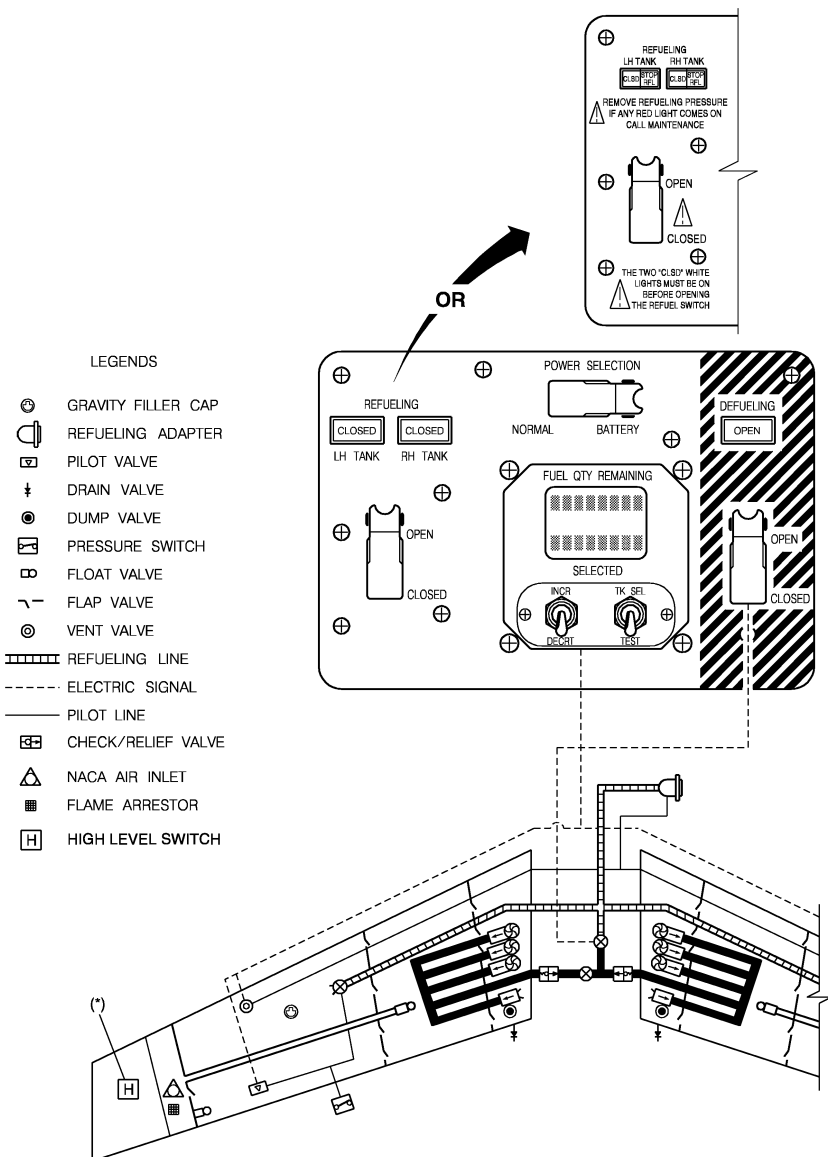
The fueling cart or fueling truck shall deliver a refueling pressure (deadhead) within 35 to 50 psi.

## DEFUELING

Pressurized defueling uses the same adapter as pressure refueling. Pressurized defueling can be performed using the electric fuel feed pumps installed in the tanks or by suction (4 psi max.) provided by an appropriated external source. Selecting the defueling switch to OPEN will open the defueling shutoff valve allowing defueling operation. To defuel the left tank, the crossfeed knob on the overhead fuel panel, in the cockpit, must be positioned to LOW2.

Complete gravity defueling may be achieved by using the drain valve and opening the associated gravity refueling cap. Partial gravity defueling can be done through the dump valves located on the wing under skin near the wing root. Pressurized defueling can only be performed with the aircraft normally energized. The power selection switch on the refueling panel does not work for refueling.

**CAUTION:** DO NOT RUN ELECTRIC PUMPS WITH FUEL QUANTITY IN EACH TANK BELOW 30 LITERS (8 US GAL) OR 24 KG (54 LB).



LEGENDS

- ⊕ GRAVITY FILLER CAP
- ☰ REFUELING ADAPTER
- ⊠ PILOT VALVE
- ⊥ DRAIN VALVE
- DUMP VALVE
- ⊠ PRESSURE SWITCH
- ⊠ FLOAT VALVE
- ⊠ FLAP VALVE
- ⊠ VENT VALVE
- ▬ REFUELING LINE
- - - - - ELECTRIC SIGNAL
- PILOT LINE
- ⊠ CHECK/RELIEF VALVE
- △ NACA AIR INLET
- FLAME ARRESTOR
- ⊠ HIGH LEVEL SWITCH

(\*) APPLICABLE TO AIRPLANES WITH HIGH LEVEL EXCEEDING INDICATION

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## PRESSURE REFUELING/DEFUELING SYSTEM SCHEMATIC

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## REFUELING PANEL

### 1 - REFUELING CLOSED LIGHTS (white)

- Illuminate when the associated refueling line is pressurized and the associated shutoff valve is closed.

### - STOP REFUELING LIGHTS (red)

- Illuminate when fuel level in the failed tank reached over the maximum quantity approved for that tank (For airplanes with High Level Exceeding Indication incorporated).

### 2 - POWER SELECTION SWITCH (guarded)

NORMAL - Refueling system is energized by the DC Bus 1.

BATTERY - Refueling system is connected to the Hot Bus 1.

### 3 - DEFUELING OPEN LIGHT (white)

- Illuminates when the defueling shutoff valve is open.

### 4 - DEFUELING SWITCH (guarded)

- Actuates the defueling shutoff valve to open or to close.

### 5 - FUEL QUANTITY REMAINING INDICATOR

- Displays fuel remaining in each tank or the total as selected by the TK SEL/TEST Switch.
- The selection is identified by the letters L, R and T (L for the left tank, R for the right tank and T for the aircraft total quantity).
- The unit of measurement (kg or lb) is also displayed.
- In case of failure, FAIL inscription is displayed blinking and the refueling/defueling operation is interrupted.
- The established accuracy of the EMB-145 airplane Fuel Quantity Gauging System (FQGS) is:  $\pm 2\%$  of the provided indication plus  $\pm 35$  kg (77 lb), considering the approved fuels and normal flight attitudes.

### 6 - TK SEL/TEST SWITCH (spring loaded to center position)

TEST - Initiates indicator built-in and probes conditions test. All light segments illuminate and a failure code is presented, if a failure is detected.

TK SEL - Selects which fuel quantity is going to be displayed in the upper display. When the indicator is energized, the total fuel quantity is shown. Sequentially pushing the switch to TKSEL will select left tank, right tank and total fuel quantity.

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**7 - QUANTITY SELECTION SWITCH (spring loaded to center position)**

- Increment (INCR) or decrement (DECRT) the fuel quantity selection.
- If moved from the neutral position during refueling, it interrupts the operation. The refueling operation will be restored 4 seconds after switch return to the neutral position.

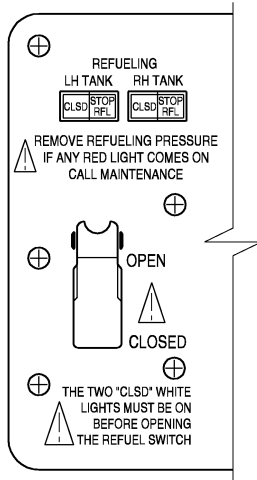
**8 - FUEL QUANTITY SELECTED INDICATOR**

- Displays the fuel quantity in the aircraft and the fuel quantity to be refueled.
- When the FAIL inscription is displayed blinking on the fuel quantity remaining indicator and the TKSEL/TEST switch is pushed to TKSEL, the active fail description is momentary displayed in both indicators.
- The indicator displays zero as the refueling compartment door is opened.

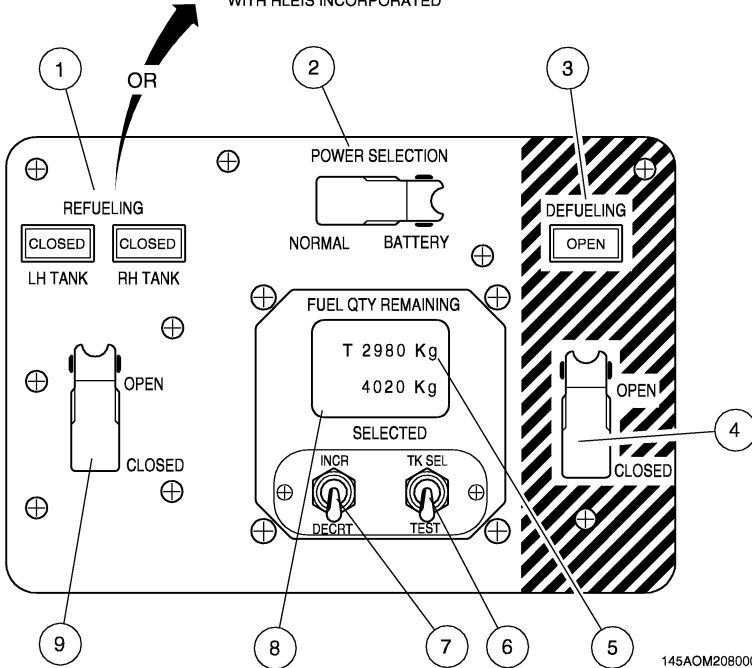
**9 - REFUELING SWITCH (guarded)**

- When the switch is closed, both wing pilot valves close the refueling shutoff valves.

**NOTE:** The defueling and the power selection switch are moved to close/normal position when the refueling panel door is closed, besides refueling/defueling procedure requires manual closure.



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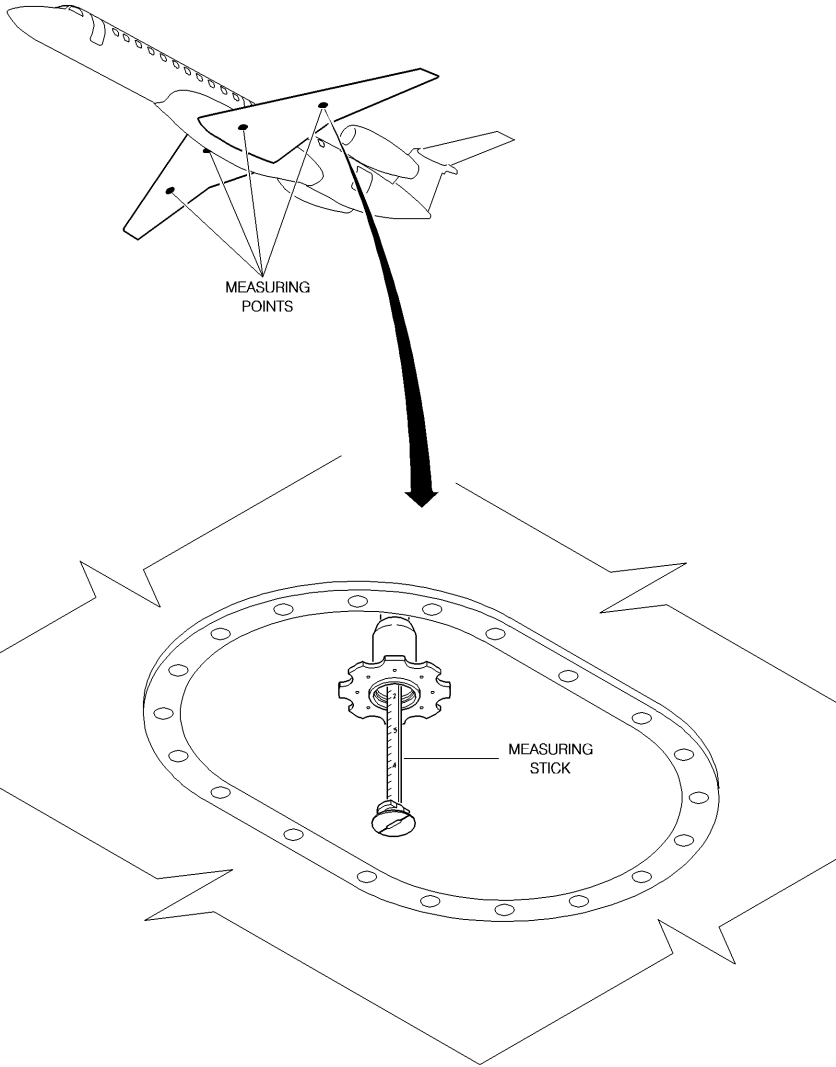
## REFUELING PANEL

## FUEL MEASURING STICK

Two measuring sticks under each wing permit to check the fuel quantity in the tanks. Each measuring stick provides visual indication of the total fuel quantity of the associated wing tank.

The table below provides minimum and maximum stick values:

STICK POSITION		AIRPLANES WITHOUT WING STUB TANK	
		LITERS	US GAL
Internal Point	Min	448	118
	Max	1553	410
External Point	Min	1503	397
	Max	2131	563



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**MEASURING STICK POINTS**

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## MEASURING STICK TABLES

To determine the fuel quantity, the airplane must be laterally leveled with roll angles between  $-1^{\circ}$  to  $+1^{\circ}$  and pitch angles between  $-2^{\circ}$  to  $+2^{\circ}$ . After refueling the airplane, start at the external measuring stick, closer to the wing tip. For airplanes without wing stub tank, between 1503 and 2131 liters (397 and 563 US gal), the external measuring stick provides a correct fuel level indication. Above 2131 liters (563 US gal), it is not possible to measure the fuel level through the measuring sticks. If the external measuring stick provides a zero indication, use the internal measuring stick to obtain the fuel level. It is also not possible to measure the fuel level through the measuring sticks, if it is below 448 liters (118 US gal).

Enter the measuring stick tables with the value read on the stick to obtain the fuel quantity (liters or US gallons). To find the fuel mass in Kg (lb) multiply the volume in liters (US gal) by the actual fuel density in Kg/l (lb/US gal).

**NOTE:** Do not add measuring sticks values.

STICK INDICATION	FUEL QUANTITY			
	INTERNAL STICK		EXTERNAL STICK	
	LITERS	US GAL	LITERS	US GAL
0.1	448	118	1503	397
0.2	455	120	1516	401
0.3	462	122	1530	404
0.4	469	124	1543	408
0.5	476	126	1556	411
0.6	483	128	1570	415
0.7	490	129	1583	418
0.8	497	131	1597	422
0.9	505	133	1610	425
1.0	512	135	1623	429
1.1	520	137	1637	432
1.2	527	139	1645	435
1.3	535	141	1663	439
1.4	543	143	1677	443
1.5	550	145	1690	447
1.6	558	148	1703	450
1.7	566	150	1717	454
1.8	574	152	1730	457
1.9	582	154	1744	461
2.0	591	156	1757	464
2.1	599	158	1770	468
2.2	607	160	1784	471
2.3	615	163	1797	475
2.4	624	165	1810	478
2.5	632	167	1824	482
2.6	641	169	1837	485
2.7	650	172	1851	489
2.8	658	174	1864	492

**MEASURING STICK TABLES (SHEET 1 OF 4)  
(AIRPLANES WITHOUT WING STUB TANK)**

STICK INDICATION	FUEL QUANTITY			
	INTERNAL STICK		EXTERNAL STICK	
	LITERS	US GAL	LITERS	US GAL
2.9	667	176	1877	496
3.0	676	179	1891	499
3.1	685	181	1904	503
3.2	694	183	1917	507
3.3	703	186	1931	510
3.4	712	188	1944	514
3.5	721	191	1957	517
3.6	730	193	1971	521
3.7	740	195	1984	524
3.8	749	198	1998	528
3.9	759	200	2011	531
4.0	768	203	2024	535
4.1	778	205	2037	538
4.2	787	208	2051	542
4.3	797	211	2064	545
4.4	807	213	2078	549
4.5	817	216	2091	552
4.6	827	218	2104	556
4.7	837	221	2118	560
4.8	847	224	2131	563
4.9	857	226	-	-
5.0	868	229	-	-
5.1	878	232	-	-
5.2	888	235	-	-
5.3	899	237	-	-
5.4	909	240	-	-
5.5	920	243	-	-
5.6	930	246	-	-
5.7	941	249	-	-
5.8	952	252	-	-

**MEASURING STICK TABLES (SHEET 2 OF 4)  
(AIRPLANES WITHOUT WING STUB TANK)**

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STICK INDICATION	FUEL QUANTITY	
	INTERNAL STICK	
	LITERS	US GAL
5.9	963	254
6.0	974	257
6.1	985	260
6.2	996	263
6.3	1007	266
6.4	1018	269
6.5	1030	272
6.6	1041	275
6.7	1052	278
6.8	1064	281
6.9	1076	284
7.0	1087	287
7.1	1099	290
7.2	1111	293
7.3	1123	297
7.4	1134	300
7.5	1146	303
7.6	1159	306
7.7	1171	309
7.8	1183	312
7.9	1195	316
8.0	1208	319
8.1	1220	322
8.2	1232	326
8.3	1245	329
8.4	1258	332
8.5	1270	336
8.6	1283	339
8.7	1296	342
8.8	1309	346

## MEASURING STICK TABLES (SHEET 3 OF 4) (AIRPLANES WITHOUT WING STUB TANK)

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STICK INDICATION	FUEL QUANTITY	
	INTERNAL STICK	
	LITERS	US GAL
8.9	1322	349
9.0	1335	353
9.1	1348	356
9.2	1361	360
9.3	1374	363
9.4	1388	367
9.5	1401	370
9.6	1415	374
9.7	1428	377
9.8	1442	381
9.9	1455	385
10.0	1469	388
10.1	1483	392
10.2	1497	395
10.3	1511	399
10.4	1525	403
10.5	1539	407
10.6	1553	410

**MEASURING STICK TABLES (SHEET 4 OF 4)  
(AIRPLANES WITHOUT WING STUB TANK)**

**AIRPLANE  
OPERATIONS  
MANUAL**



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