**ON A/C ALL

76–00–00–001

ENGINE CONTROLS, GENERAL

Introduction

The engine controls provide power management and propeller control. The emergency shutdown controls provide a means to shutdown the engine(s) in an emergency situation.

General Description

Refer to Figures 1 and 2.

The controls for each engine consist of power and condition levers. The power levers are identified as #1 and #2 engine and the condition levers are similarly identified.

Refer to Figure 3.

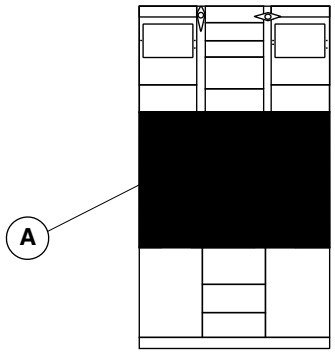
Emergency shutdown is supplied to stop the flow of fuel to the engine. At the same time, the flow of hydraulic fluid to the engine–installed hydraulic pump is stopped.

Detailed Description

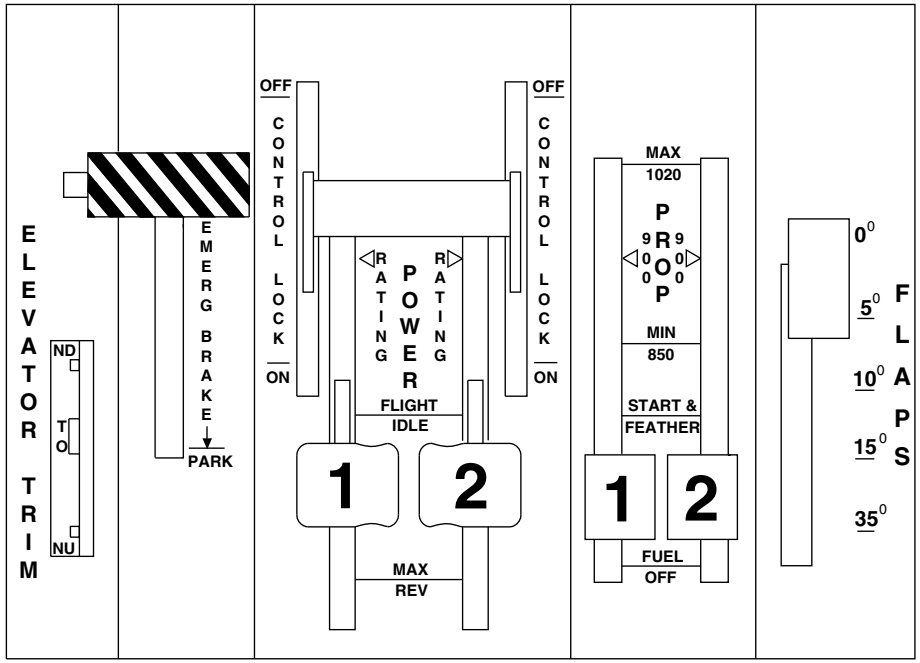
The power lever system is used to initiate fuel demands through the Full Authority Digital Electronic Control (FADEC) to drive the turbomachinery section of the engine, in the forward and reverse ranges. The power lever also initiates control signals to the Propeller Electronic Control (PEC) to control propeller blade angles in the beta range to full reverse.

The condition lever system initiates signals to the PEC, to control the propeller blade angles in the forward and reverse ranges. The condition lever also controls fuel on and fuel off, propeller feather and unfeather, and propeller speeds.

The PULL FUEL/HYD OFF handle is used to initiate an emergency shutdown of the engine. When the handle is pulled the fuel emergency shut off valve is energized to the closed position causing an engine shutdown, by shutting off the fuel supply. Operating the handle also energizes the hydraulic emergency shutoff valve to the closed position, shutting off hydraulic fluid supply to the EDP (Engine Driven Pump)



CENTRE CONSOLE



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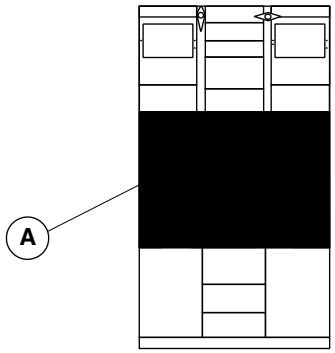
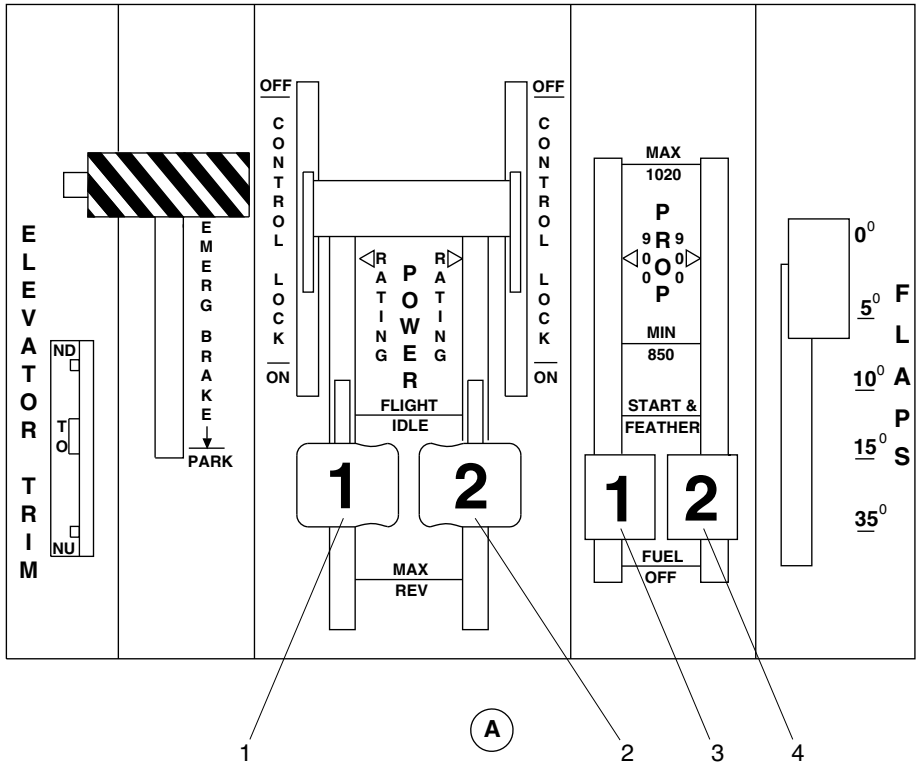
Power and Condition Levers Location
Figure 1



CENTRE CONSOLE



LEGEND

1. #1 Power Lever.
2. #2 Power Lever.
3. #1 Condition Lever.
4. #2 Condition Lever.

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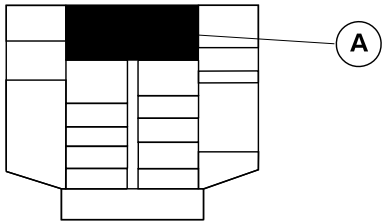
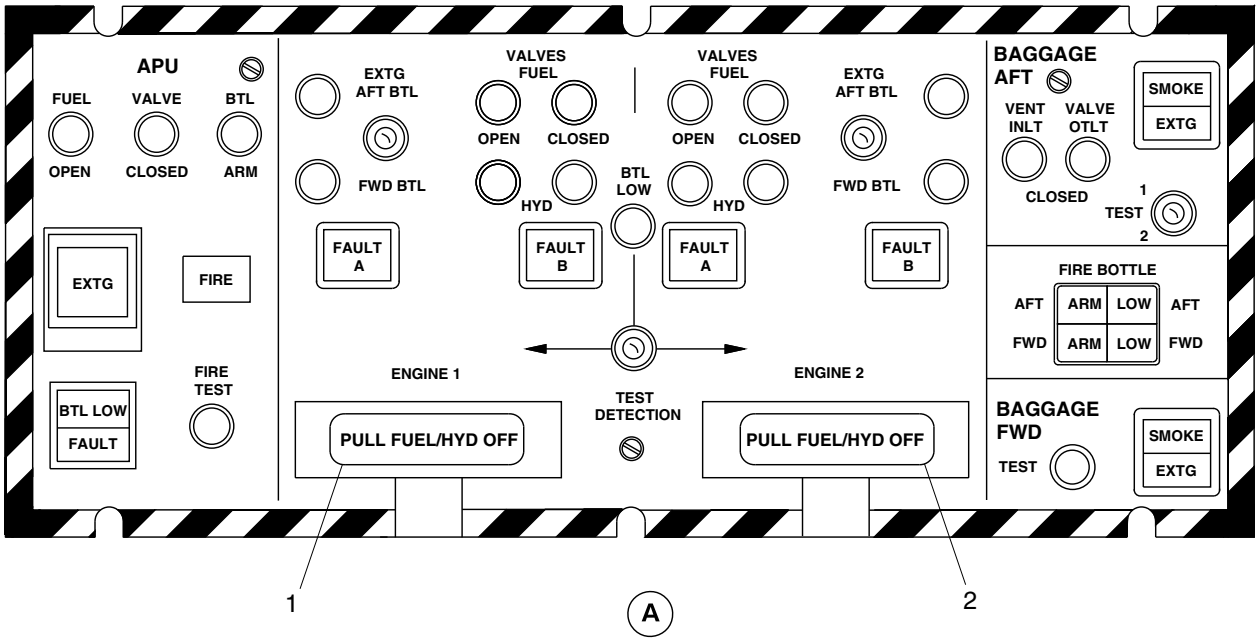
Power and Condition Levers Detail
Figure 2



OVERHEAD CONSOLE

LEGEND

1. Engine 1 Pull Fuel/ Hydraulic Shut Off Handle.
2. Engine 2 Pull Fuel/ Hydraulic Shut Off Handle.



NOTE

The fire protection panel may vary for the aircraft with cargo combi configuration.

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Power Control General, Fire Protection Panel
Figure 3

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**ON A/C ALL

76–10–00–001

POWER CONTROL

Introduction

The engine controls provide power management and propeller control

General Description

Refer to Figure 1.

The controls for each engine consist of power and condition levers. The power levers are identified as #1 and #2 engine and the condition levers are similarly identified.

The power lever system is used to initiate fuel demands through the Full Authority Digital Electronic Control (FADEC) to drive the turbomachinery section of the engine, in the forward and reverse ranges. The power lever also initiates control signals to the Propeller Electronic Control (PEC) to control propeller blade angles in the beta range to full reverse.

The condition lever system initiates signals to the PEC, to control the propeller blade angles in the forward and reverse ranges. The condition lever also controls fuel on and fuel off, propeller feather and unfeather, and propeller speeds.

Detailed Description

The FADEC and the PEC get electrical signals from the Rotary Variable Differential Transformers (RVDTs) and the microswitches of the power lever and condition lever. These electrical signals are computed by the FADEC and PEC. FADEC and PEC electronically control the engine and propeller to suit the selected Power Lever Angle (PLA), Condition Lever Angle (CLA) and the operating mode.

A flight idle gate for the power levers prevents inadvertent selection of engine ground beta and reverse operation. Lift stops for the condition lever prevent inadvertent selection of propeller feather and fuel shutoff. A warning tone is generated by the aural warning system when:

- Radio altimeter output is more than 20 ft (6.1 m)
- and PLA is at flight idle or lower
- and the power lever trigger is lifted.

Power Lever Quadrant

Refer to Figure 2.

Power lever movement is limited by fixed stops at both ends of the quadrant. Each lever has the distinct settings that follow:

- RATING (rated power detent)
- FLIGHT IDLE (detent and gate)
- DISC (detent)
- MAX REVERSE (detent and stop)

RATING. With the power lever in the RATING, or rated power, detent the engine will deliver the horsepower demanded by the rating

selections. The rating selection is by Condition Lever Angle (CLA) or by rating select switches on the engine control panel.

FLIGHT IDLE. The flight idle gate lets the power lever have freedom of movement in the forward direction, toward the rated power detent. The flight idle gate does not impose any restriction, that would cause the pilot to perform a separate action before being able to reach the rated power setting. As the lever is moved rearward, towards reverse, it meets a gate at the flight idle setting. The pilot must operate the release lever, to permit entry of the power lever into the ground regime. The operation of the release lever lets only the power lever with the release lever selected, to enter the ground regime. It is not possible to raise the release lever, until the affected power lever is at the flight idle gate. A warning tone is generated if the trigger is lifted during flight. Each lever has an overtravel margin beyond the RATING detent, to let the pilot select 25% extra power for emergency operation only.

DISC. With the power lever in the DISC detent the engine will supply minimum power.

MAX REVERSE. With the power lever in the detent the engine will supply a maximum of 1000 Shaft horsepower (746 kW)

A friction knob for both power levers is installed in the centre console below the power levers. Turning the knob in the FRICTION INCREASE direction, as marked, progressively increases friction and prevents movement. The friction load can be reduced by turing the knob in the opposite direction.

A flight control gust lock handle is installed forward of the power levers. When the handle is in the ON position, the power levers cannot be advanced to the take off position, because of physical interference of the gust lock handle.

Refer to Figure 3.

Refer to Figure 4.

Each power lever drives two identical RVDTs on a common shaft, one for each FADEC channel. The FADEC provides the excitation for the RVDTs, and power lever position is represented by a proportional ac voltage at the FADEC. Four microswitches are operated by the power lever, one at each of the positions that follow:

- PLA at 33 degree Flight idle –2 degree position _ low PLA. Ground Beta Enable Switch for propeller control in Discing and Reverse.
- PLA at 47 degree Flight idle +12 degree position _ low PLA. Spoiler Lift Dump Switch armed
- PLA at 60 degree or above_ high PLA input for Autofeather Arming system
- PLA at 60 degree or above_ high PLA for pre–pressurization function in Cabin Pressure Control System

A Go–around switch is installed in each power lever to supply go–around commands on the two Electronic Attitude Direction Indicators (EADIs).

Condition Lever Quadrant

The condition levers are installed in the pilots' control pedestal, to the right of the power levers. Each condition lever has five distinct settings in the console slot. The positions are marked on the quadrant to indicate the propeller control range, engine start and propeller setting and fuel shutoff position.

The markings of the condition lever detents are as follows:

- MAX (1020)
- 900 RPM
- MIN (850)
- START FEATHER
- FUEL OFF

MAX 1020. With the CLA in this position and the PLA in the RATING detent, Normal Take Off Power (NTOP) at 1020 Np is demanded.

900RPM. With the CLA in this position and the PLA in the RATING detent, Maximum Climb Power (MCL) at 900 Np is demanded.

MIN 850. With the CLA in this position and the PLA in the RATING detent, Maximum Cruise Power (MCR) at 850 Np is demanded

START FEATHER. With the CLA in this position, the propeller is in the feathered condition and the torque bug is set to NTOP.

FUEL OFF. With the CLA in this position, fuel to the engine is cut off.

A spring loaded roller installed in each condition lever, operating in conjunction with the detent track, provides the detents at the positions above. Propeller MAX setting is limited by a fixed stop at the forward end of the quadrant.

As the lever is moved rearward, toward the FUEL OFF position, it meets a gate at the MIN position. The condition lever knob must be lifted to remove the gate and let lever operation continue. There is another gate at the START FEATHER position and the condition lever knob must be lifted, to let the lever reach the FUEL OFF position. The two gates permit forward movement of the lever without lifting the lever knob. Lever movement at FUEL OFF is limited by a fixed stop at the rear of the quadrant.

A friction brake knob for both condition levers, is installed in the centre console, below the levers. Rotating the knob in the marked FRICTION INCREASE direction, progressively increases friction. The friction load can be decreased by turning the knob in the opposite direction.

Each condition lever drives two identical Rotary Variable Differential Transducers (RVDTs) on a common shaft. The RVDTs signal the PEC on Condition Lever Angle (CLA). Four switches are operated by each condition lever at the positions that follow:

- CLA at 15 degree or below — Engine Start/Shutdown Switch (Dual) send fuel off signals to the FADEC.
- CLA at 15 degree or below— Engine Hydraulic Pump Caution Switch, ensures light on when propeller feathered.
- CLA at 40 degree or above— high CLA inhibits alternate feather function through Alternate Feather Lockout Switch.

Engine Control Panel

The engine control panel is installed on the centre console, forward of the power and condition levers.

On aircraft with Modsum 4Q457199 or SB 84–24–31 incorporated (Refer to Figure 5.), the panel has the buttons and the switchlights that follow:

- Maximum Take Off Power (MTOP) switchlight
- Reduced Propeller RPM (RDC Np LDG) switchlight
- Maximum Climb Power (MCL) switchlight

- Maximum Cruise Power (MCR) switchlight
- Reduced Power Take Off (RDC TOP) DEC and RESET buttons
- EVENT MARKER button.

On aircraft with Modsums 4Q126102, 4Q126010 or 4Q201568 incorporated (Refer to Figure 6.), the panel has the buttons and the switchlights that follow:

- Maximum Climb Power (MCL) switchlight
- Maximum Cruise Power (MCR) switchlight
- Reduced Power Take Off (RDC TOP) DEC and RESET buttons
- EVENT MARKER button.

On aircraft with Modsum 4Q901333, Option 803CH00164 or SB84–24–11 incorporated (Refer to Figure 7.), the panel has the buttons and the switchlights that follow:

- Maximum Take Off Power (MTOP) switchlight
- Maximum Climb Power (MCL) switchlight
- Maximum Cruise Power (MCR) switchlight
- Reduced Power Take Off (RDC TOP) DEC and RESET buttons
- EVENT MARKER button.

On aircraft with Modsum 4Q901332, Option 803SO90030 or SB84–24–10 or SB84–76–06 incorporated (Refer to Figure 8.), the panel has the buttons and the switchlights that follow:

- Reduced Propeller RPM (RDC Np LDG) switchlight
- Maximum Climb Power (MCL) switchlight
- Maximum Cruise Power (MCR) switchlight
- Reduced Power Take Off (RDC TOP) DEC and RESET buttons
- EVENT MARKER button.

Pushbutton and switchlight selections are transmitted as momentary discretes to the Engine Cockpit Interface Unit (ECIU). In the ECIU the discretes are converted to ARINC 429 labels and transmitted to FADEC. The selected rating stays latched until another selection is made on the CLA, pushbutton or switchlight.

MTOP switchlight

Allows selection of maximum take off power if CLA is at 1020 and PLA is at the RATING detent.

RDC Np LDG switchlight.

Refer to Figure 9.

Used to select reduced Np for noise reduction during take–off or landing using logic in the FADEC. For reduced Np during take–off the following conditions apply:

- CLA at 1020
- PLA at more than 80 degrees
- Aircraft on the ground.

Operating the Reduced Np switchlight will reset Np from 1020 to 960 rpm and the Engine Display (ED) will show REDUCED NP

TAKE–OFF. If MTOP is selected on the engine control panel, Reduced Np is disabled and Np reverts to 1020 rpm.

For reduced Np during landing the following conditions apply:

- CLA at MIN 850
- PLA less than 60 degrees
- Aircraft in flight

Operating the Reduced Np switchlight will cause the Np to stay at 850 rpm when the CLA is moved to 1020, (normal position for landing). REDUCED NP LANDING will be shown on the ED. Reduced NP for landing is disabled in the event of go–around or uptrim.

MCL switchlight.

With a MCR selection of CLA at MIN 850 position and PLA in the RATING detent, selecting the MCL switchlight changes the engine rating to MCL at 850 Np.

MCR switchlight

With a MCL selection of CLA at 900 rpm and PLA in the RATING detent, selecting the MCR switchlight changes the engine rating to MCR at 900 Np.

Reduced Take Off buttons

Pressing the DEC button reduces NTOP by 2%. This reduction can be used up to a maximum of 10%. Pressing the RESET button resets NTOP.

EVENT MARKER button

When selected, highlights engine parameters for 2 minutes before the selection, to 1 minute after the selection in the Engine Monitoring System (EMS)

Propeller Control Panel

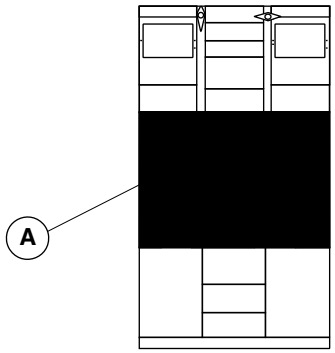
The propeller control panel is installed on the centre console , forward of the power and condition levers. The panel has the two guarded alternate feather pushbuttons and one autofeather pushbutton.

#1 and #2 ALT FTHR pushbuttons

When pushed the buttons initiate propeller feather of the selected engine if autofeather is not possible.

AUTOFEATHER pushbutton

When selected completes part of the arming parameters for the automatic propeller feathering system.



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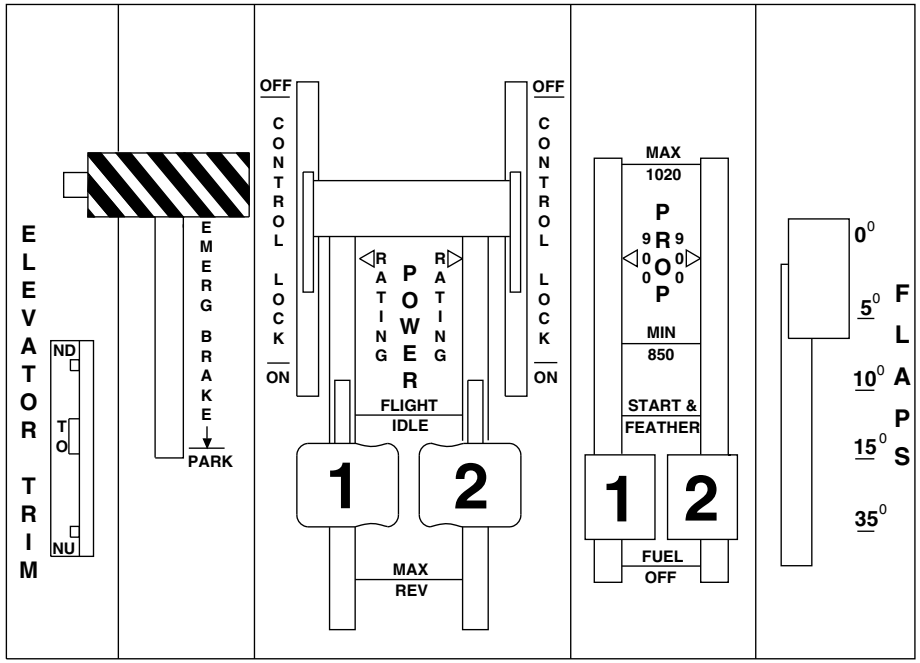

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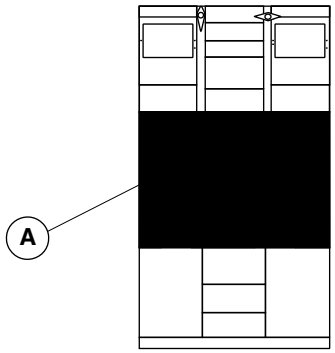
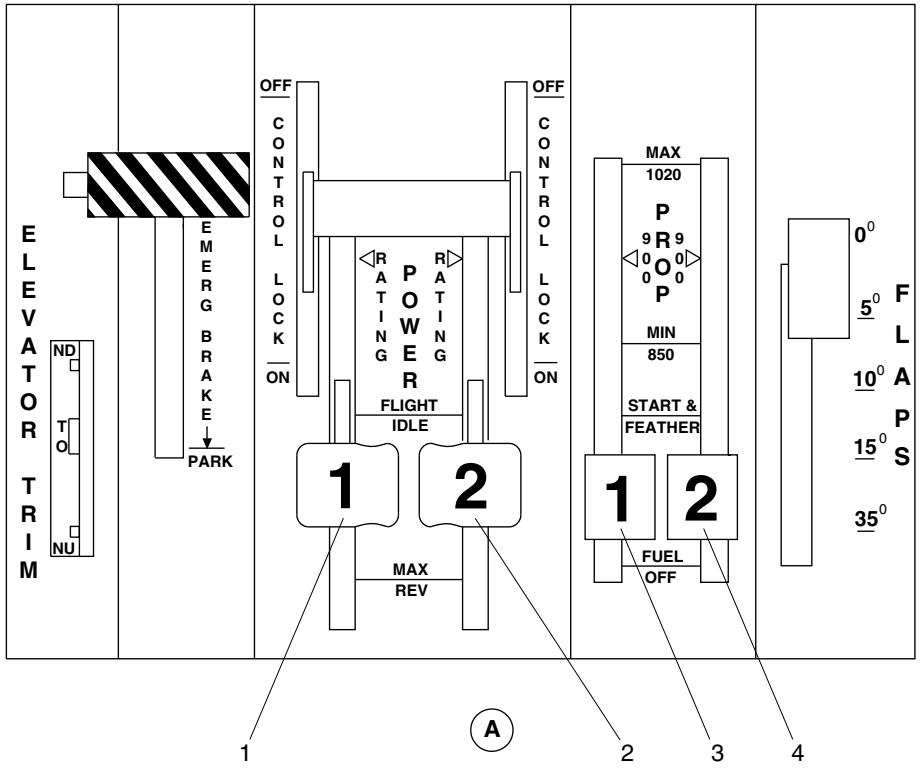
Power and Condition Levers Location
Figure 1



CENTRE CONSOLE



LEGEND

1. #1 Power Lever.
2. #2 Power Lever.
3. #1 Condition Lever.
4. #2 Condition Lever.

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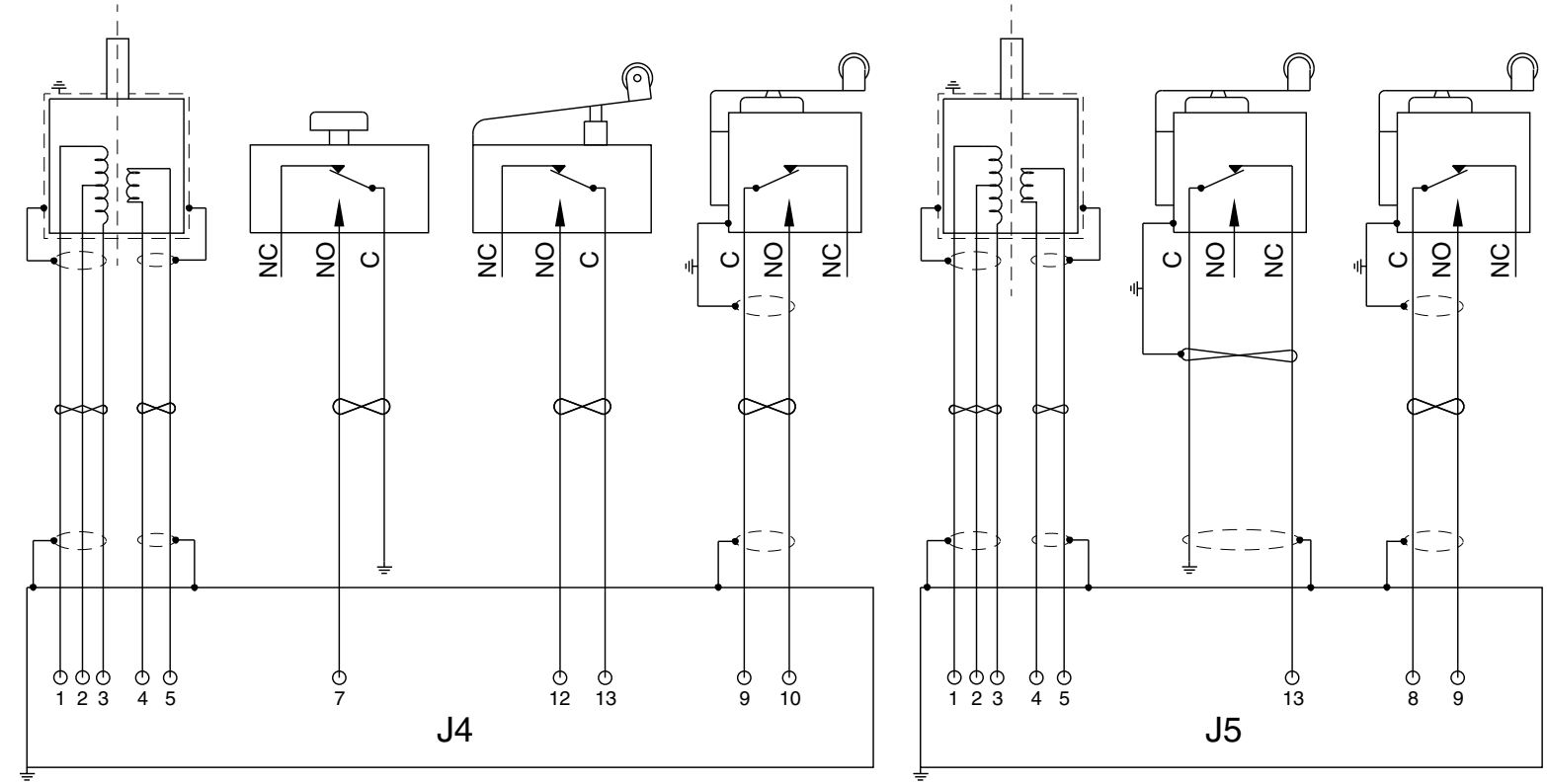
Power and Condition Levers Detail
Figure 2

RVDT	SWITCH	SWITCH	SWITCH	RVDT	SWITCH	SWITCH
0° TO 100° LEFT PLA	LEFT GO AROUND	LEFT TRIGGER	LEFT 33° PLA	0° TO 100° RIGHT PLA	RIGHT 47° PLA	RIGHT 60° PLA



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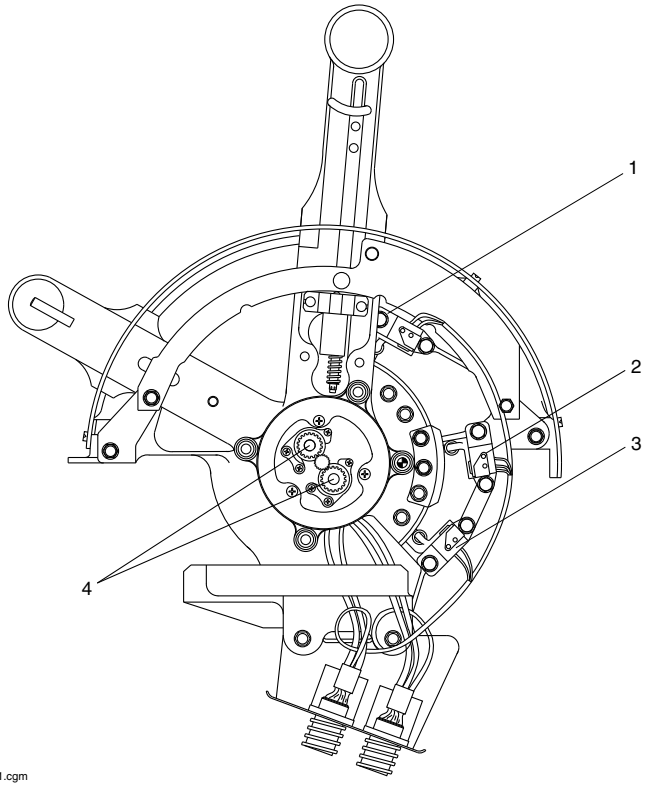
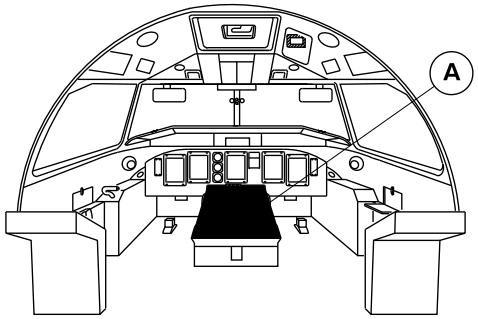
Power Lever RVDTs and Microswitches Schematic
Figure 3



LEGEND

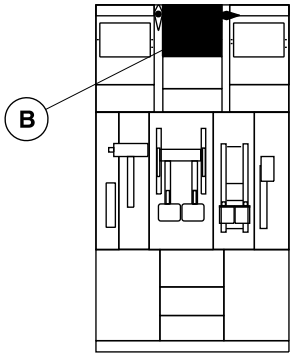
1. High PLA 60° Autofeather Arming Switch Pre–pressurization Switch.
2. Low PLA 47° Spoiler Lift Dump Switch.
3. Low PLA 33° Ground Beta Enable Switch.
4. Rotary Variable Differential Transformers (RVDTs).

Power Lever Microswitches
Figure 4

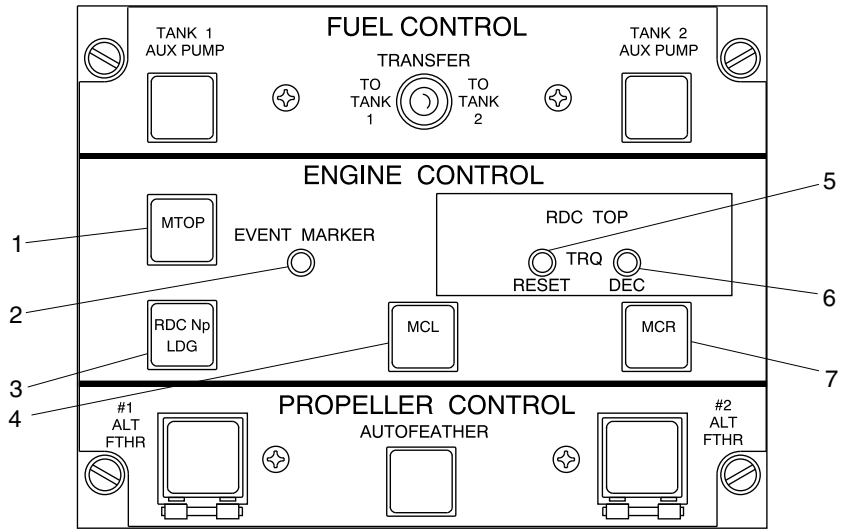


LEGEND

1. Maximum take–off power pushbutton select switch.
2. Event marker pushbutton switch.
3. Reduced propeller speed pushbutton select switch.
4. Maximum climb power pushbutton select switch.
5. Take–off power reset pushbutton switch.
6. Reduced take–off power pushbutton switch.
7. Maximum cruise power pushbutton select switch.



A **CENTER CONSOLE**



B **POST MODSUM 4–457199 OR SB84–24–31**

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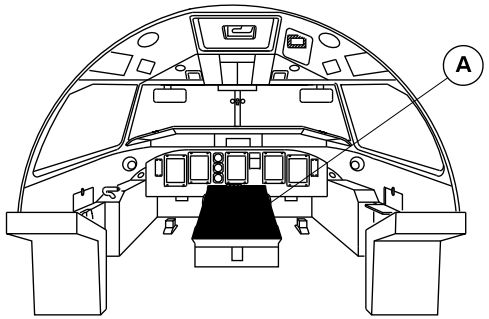
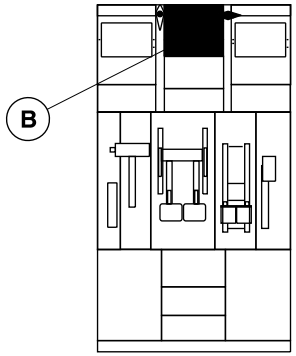
Engine Control Panel
Figure 5



LEGEND

1. Event marker pushbutton switch.
2. Maximum climb power pushbutton select switch.
3. Take–off power reset pushbutton switch.
4. Reduced take–off power pushbutton switch.
5. Maximum cruise power pushbutton select switch.



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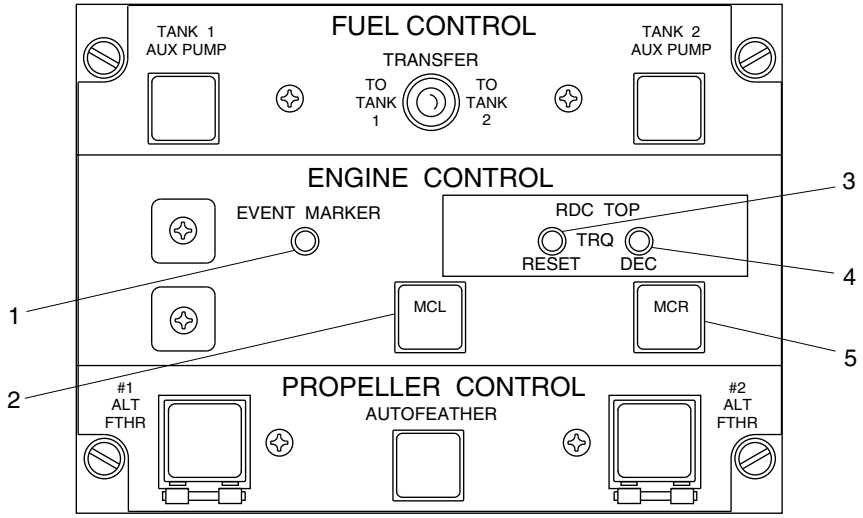

(B) **POST MODSUM 4–126102, 4–126010 OR 4–201568**

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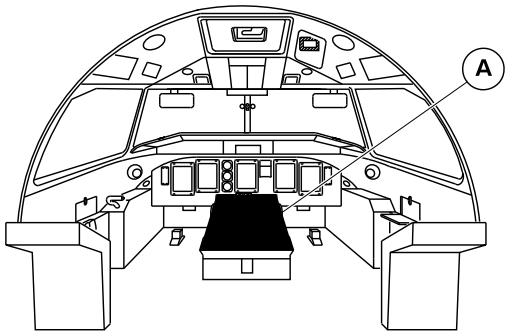
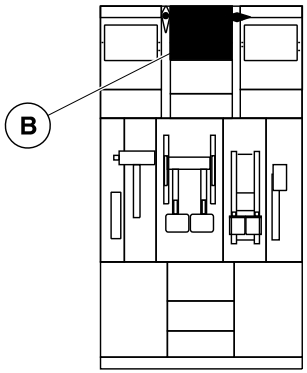
Engine Control Panel
Figure 6



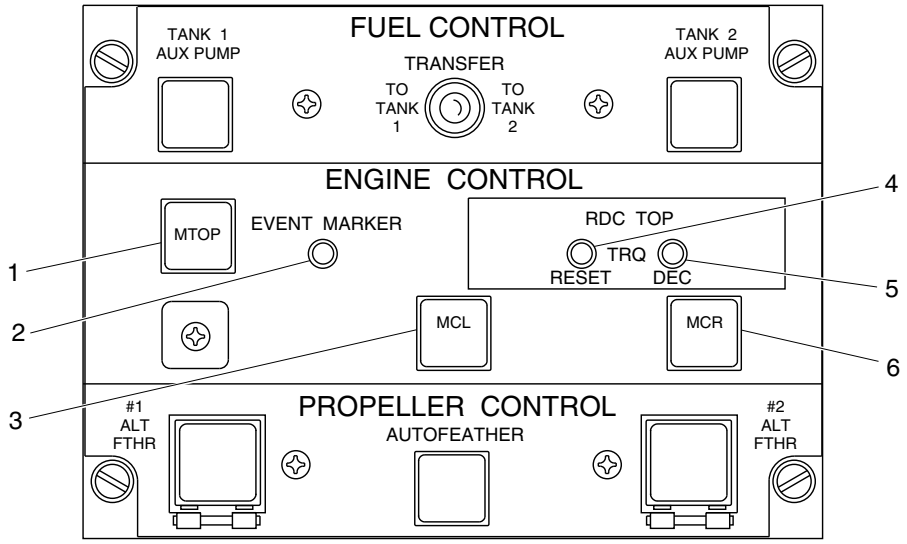


A

CENTER CONSOLE

LEGEND

1. Maximum take–off power pushbutton select switch.
2. Event marker pushbutton switch.
3. Maximum climb power pushbutton select switch.
4. Take–off power reset pushbutton switch.
5. Reduced take–off power pushbutton switch.
6. Maximum cruise power pushbutton select switch.



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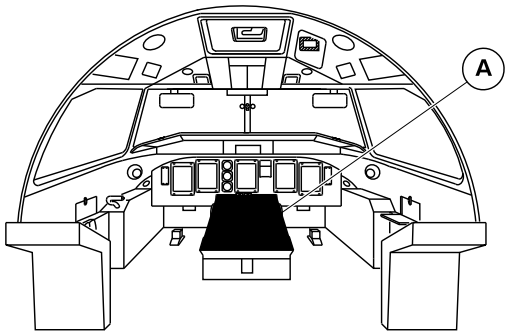
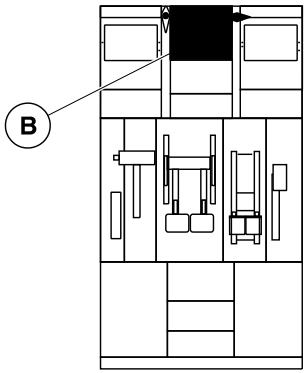
Engine Control Panel
Figure 7



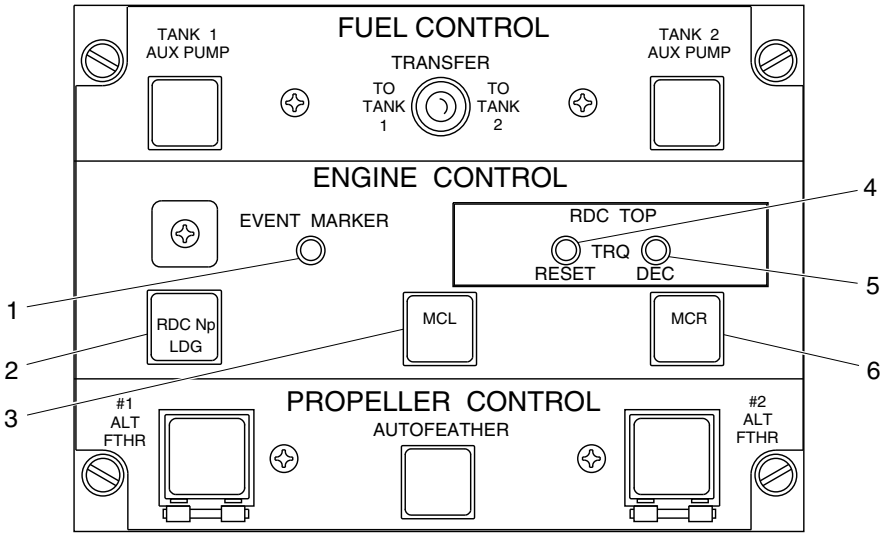


A

CENTER CONSOLE

LEGEND

1. Event marker pushbutton switch.
2. Reduced propeller speed pushbutton select switch.
3. Maximum climb power pushbutton select switch.
4. Take–off power reset pushbutton switch.
5. Reduced take–off power pushbutton switch.
6. Maximum cruise power pushbutton select switch.



B

POST MODSUM 4–901332, OPTION 803SO90030 OR SB84–24–10 OR SB84–76–06

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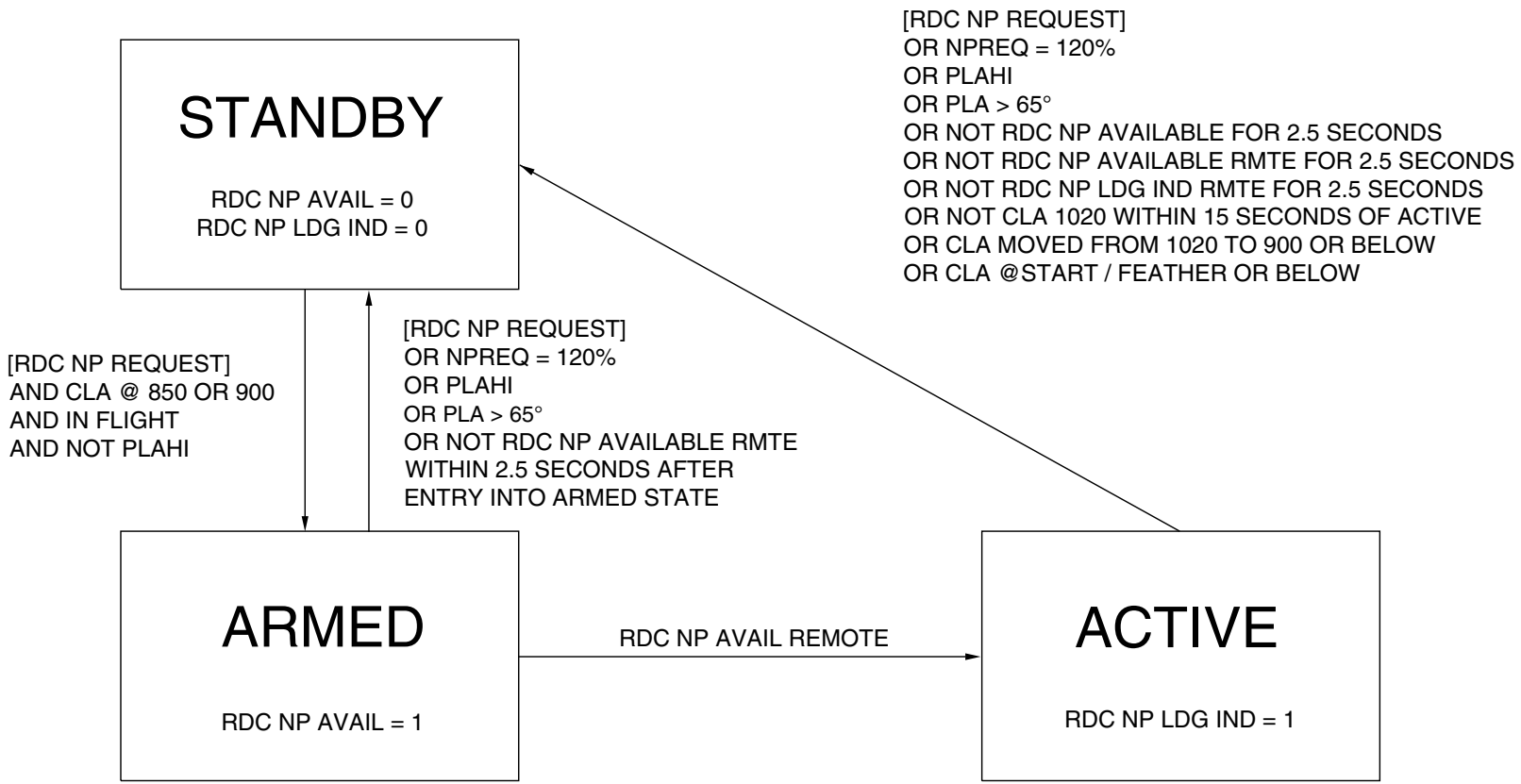
Engine Control Panel
Figure 8



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State Transition Diagram – Reduced Np Landing
Figure 9

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76–20–00–001

EMERGENCY SHUTDOWN

Introduction

The description that follows gives the operation of the components for the emergency shutdown of the No. 1 engine. The No. 2 engine emergency shutdown components and their operation are the same.

General Description

Emergency shutdown is supplied to stop the flow of fuel to the engine. At the same time, the flow of hydraulic fluid to the engine–installed hydraulic pump is stopped. The components that follow are supplied for each engine:

- A PULL FUEL OFF handle for each engine
- A fuel emergency shutoff valve for each engine
- A hydraulic emergency shutoff valve for each engine
- Relays
- Circuit protection
- Position indication.

Detailed Description

PULL FUEL OFF Handle

Refer to Figures 1 and 2.

The PULL FUEL OFF handles are on the fire protection panel in the flight compartment. Red lights are installed in the handles. They come on to give indication of a fire. The handles are operated manually. The handle must be pulled to complete the circuits to close the emergency fuel and hydraulic shutoff valves.

When the PULL FUEL OFF handle is moved, the handle activates the limit switches in the handle. This electrically energizes the valve close circuits. The valves go to the CLOSED position. With the valves CLOSED, limit switches in each valve are operated. One limit switch operates to remove electrical power to the close side of the valve motor. The other limit switch operates to arm the valve OPEN circuits. With the PULL FUEL OFF handle pulled, fire extinguishing circuits are armed (Ref. AMM 26–21–00 — Engine Fire Extinguishing System).

With the PULL FUEL OFF handle in the normal position, fire extinguishing circuits are disarmed (Ref. AMM 26–21–00 — Engine Fire Extinguishing System). The FUEL VALVE CLOSED lights go out and the valves move to the open position. Limit switches in each valve are operated at the valve OPEN position as follows:

- One limit switch to shutdown the valve motor
- The other limit switch to arm the valve close circuits.

Emergency Fuel Shutoff Valve

The emergency shutoff valves are installed on the main wing rear spar. There is a valve on each wing, one for each engine. With the 28 Vdc essential buses and the batteries energized, relays 2822–K1

and 2822–K2 energize. With the PULL FUEL OFF handles in the normal (pushed–in) position, the valves are open. 28 Vdc power from the battery bus is supplied through the normally closed contacts in the handles to the valve open circuits in the related fuel and hydraulic shutoff valves.

The electrically energized valves are each supplied with a mechanical position indicator. Limit switches in the valves control valve motor start/stop operation. The valves are assembled with thermal relief protection. The valves are connected electrically to limit switches in the related PULL FUEL OFF handle. This completes the valve open and close circuits. The circuit for each valve is energized from the 28 Vdc battery bus. The valves are supplied with circuit protection by a 7.5 A circuit breaker. The close circuit of the emergency fuel shutoff valve gets a 28 Vdc supply from the close circuit of the related hydraulic emergency shutoff valve through a blocking diode when the hydraulic valve close circuit energizes.

Emergency Hydraulic Shutoff Valve

The emergency hydraulic shutoff valves are installed, one in each nacelle for the related engine. With the 28 Vdc essential buses and the batteries energized, relays 2822–K1 and 2822–K2 energize. With the PULL FUEL OFF handles in the normal (pushed–in) position, the valves are closed. 28 Vdc power from the battery bus is supplied through the N C contacts in the handles. 28 Vdc is supplied to the valve open circuits in the related fuel and hydraulic shutoff valves.

The electrically–powered valves are each supplied with a mechanical position indicator. The valves are assembled with thermal relief protection. Limit switches in the valves control valve motor start/stop operation. The valves are connected electrically to limit switches in the related PULL FUEL OFF handle. This completes the valves open and close circuits.

The circuit for each valve is energized from the 28 Vdc battery bus. They are supplied with circuit protection by a 7.5 A circuit breaker. The close circuit of the emergency hydraulic shutoff valve gets a 28 Vdc supply to the close circuit of the related hydraulic emergency shutoff valve through a 28 Vdc battery bus when the PULL FUEL OFF handle is pulled.

Relays

The relays are electrically energized from the 28 Vdc essential buses. Relay K1 is energized through the left dc essential bus, and relay K2, through the right dc essential bus. The relays, on relay panel No. 1, in the cabin, are connected to the fuel valve light circuits.

Position Indication

Refer to Figure 2.

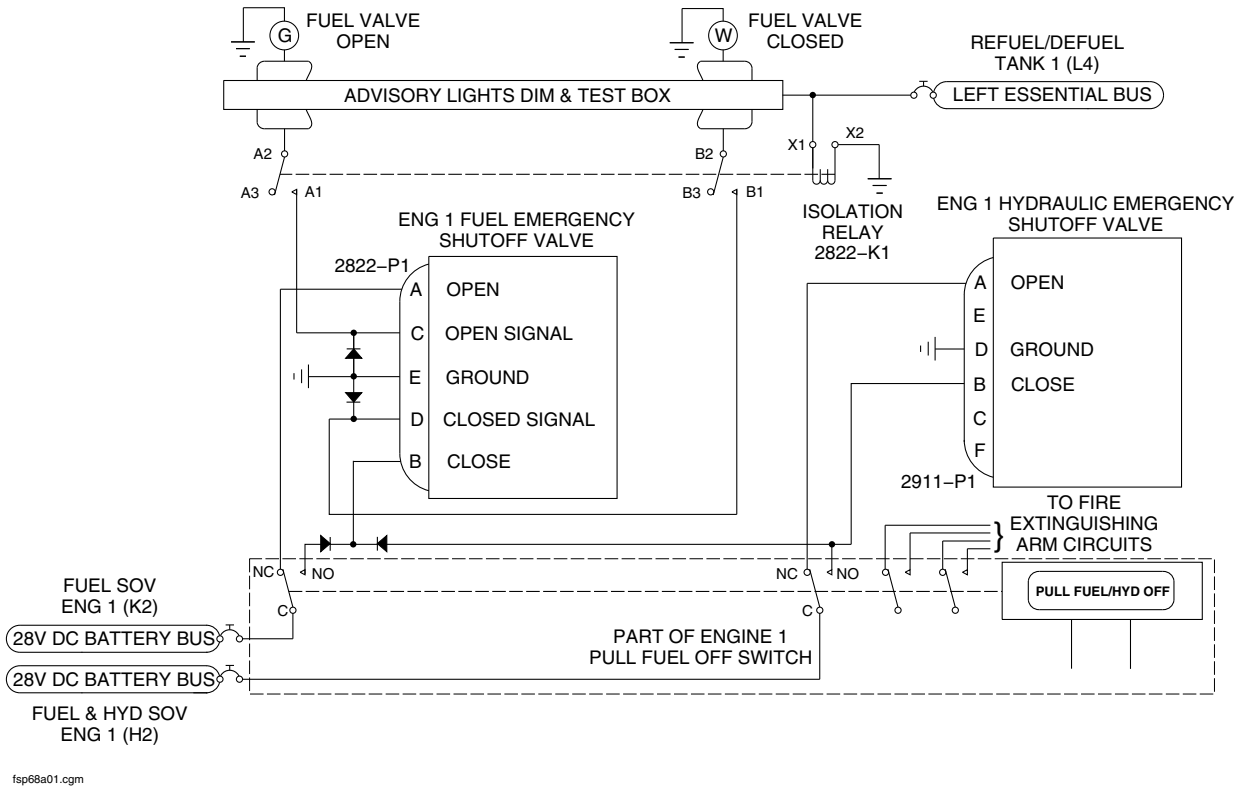
Fuel valve position is shown by a FUEL VALVE CLOSED, or a FUEL VALVE OPEN light. The lights are on the fire protection panel, and the electrical circuit is through the advisory lights dim and test box. The valve position indicator lights come on if the buses are electrically energized (BATTERY MASTER switch ON). When the fuel valves get to the open position, the FUEL VALVE OPEN lights come on. This is shown by the movement of the visual indicator (pencil lever) on each valve. With power removed from the aircraft buses, (BATTERY MASTER switch OFF) relays 2822–K1 and 2822–K2 do not get electrical power. The isolation relays 2822–K1, and 2822–K2 isolate the valve position lights circuits from the battery

power. This is done when electrical power is removed from the aircraft buses.

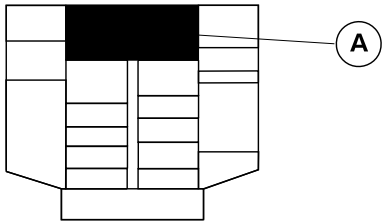
The fuel emergency shutoff valves are electrically connected to the valve OPEN and to the valve CLOSED indicator lights. The fuel emergency shutoff valves also give a visual indication of valve position with a mechanical position (pencil lever) indicator, installed on the valve. When the circuits are not energized, you can manually operate the indicators on the fuel valves to the CLOSED, or to the OPEN position. The mechanical position indicator shows the valve position, between CLOSED and OPEN.

Circuit Protection

The relays are given protection by the 5 A REFUEL/DEFUEL TNK 1 (L4) and REFUEL/DEFUEL TNK 2 (F4) circuit breakers, on the left and right essential bus circuit breaker panels. The No. 1 engine fuel emergency shutoff valve is supplied with protection by a FUEL SOV ENG 1 circuit breaker (K2). No. 1 engine hydraulic shutoff valve is supplied with protection by a FUEL & HYD SOV ENG 1 (H2) circuit breaker. The circuit breakers are found on the 28 Vdc right essential panel. The No. 2 engine fuel emergency shutoff valve is supplied with protection by a FUEL SOV ENG 2 circuit breaker (L2). The hydraulic emergency shutoff valves give a visual indication of valve position. The indication is with the mechanical position indicator installed on the valve. The mechanical position indicator shows the valve position, between CLOSED and OPEN. No. 2 engine hydraulic shutoff valve is supplied with protection by a FUEL & HYD SOV ENG 2 (J2) circuit breaker. The circuit breakers are found on the 28 Vdc right essential panel.



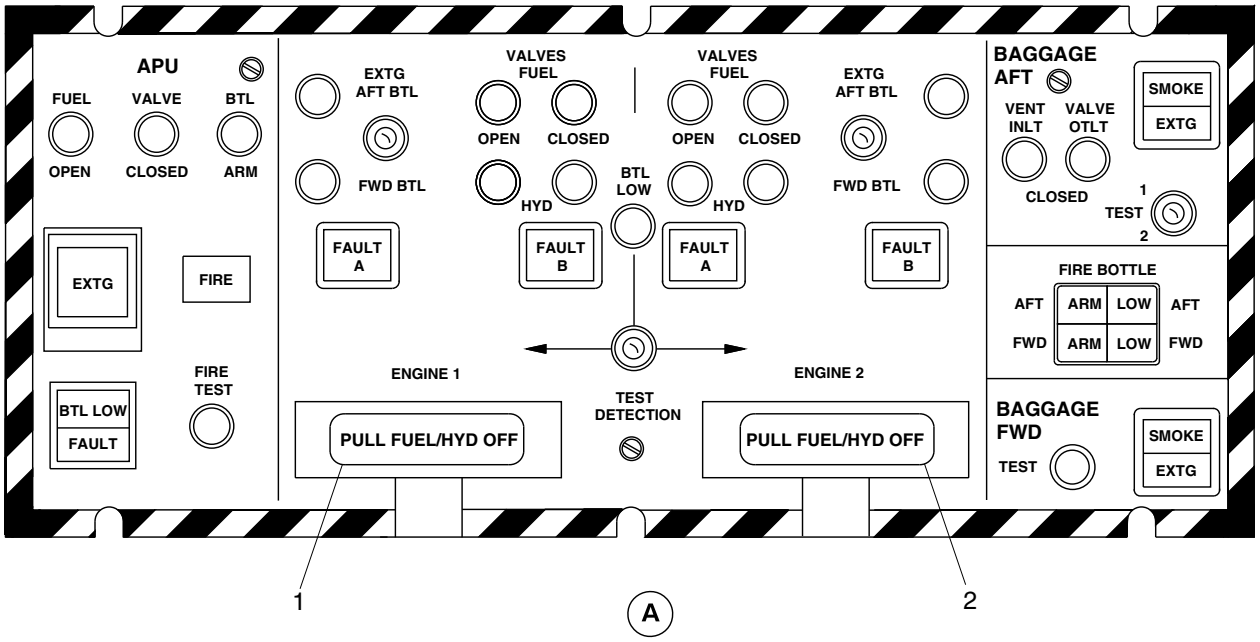
Emergency Shutdown — Electrical Schematic
Figure 1



OVERHEAD CONSOLE

LEGEND

1. Engine 1 Pull Fuel/ Hydraulic Shut Off Handle.
2. Engine 2 Pull Fuel/ Hydraulic Shut Off Handle.



NOTE

The fire protection panel may vary for the aircraft with cargo combi configuration.

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Fire Protection Panel Multilayer Detail
Figure 2