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#### 54-00-00-001

## NACELLES/PYLONS, GENERAL

#### Introduction

The nacelle makes an aerodynamic surface around the power plant. The power plant, exhaust assembly, wing structure, and main landing gear are also contained in the nacelle.

The forward nacelle extends forward from the wing front spar frame and contains the main support structure for the propulsion system.

The nacelle center section extends from the nacelle forward section to the lower aft section.

The nacelle aft section extends aft from the aft spar.

## **General Description**

### Refer to Figures 1 and 2.

Each nacelle has the three parts that follow:

- Forward Nacelle (54–10–00)
- Center Nacelle (54–20–00)
- Aft Nacelle (54–30–00).

### Refer to Figure 3.

The forward nacelle encloses the engine mounting structure that supports the propeller, gearbox, engine, systems and cowlings.

Engine operating and aerodynamic loads are transferred through the structure to the nacelle centre section and wing box.

### Refer to Figure 4.

The nacelle centre section houses the main landing gear and wing nacelle attachments points.

#### Refer to Figure 5.

The nacelle aft section houses part of the exhaust assembly, and the main landing gear wheels when it is retracted. It includes the structure of the lower fairing and the forward and aft upper fairings.

#### **Detailed Description**

Each engine is housed in a nacelle installed below the wing.

The nacelle houses the components that follow:

- Main landing gear
- Engine exhaust
- Landing gear accessories

## **Forward Nacelle**

The forward nacelle is a housing for the power plant. It includes the structure of the engine mount system, fairings and access doors, and lower cowl.

#### **Center Nacelle**

The center nacelle is a housing for the wing structure, the forward part of the exhaust assembly, and where the main landing gear

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attaches. It includes the structure of the 'A' frame, two main side frames, and rear bulkhead.

#### **Aft Nacelle**

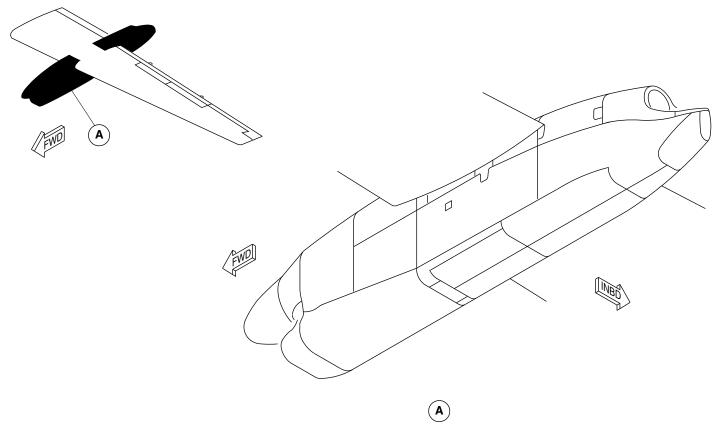
The aft nacelle is a housing for the aft part of the exhaust assembly, and the main landing gear wheels (when retracted). It includes the structure of the lower fairing and the forward and aft upper fairings.

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Nacelle Locator Figure 1

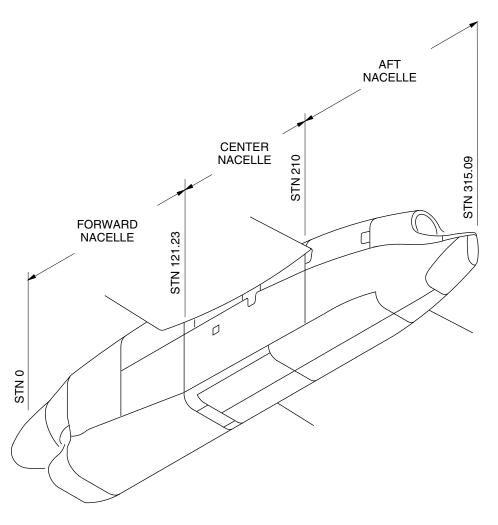
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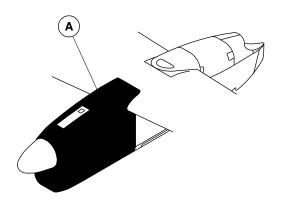
Nacelle Detail Figure 2

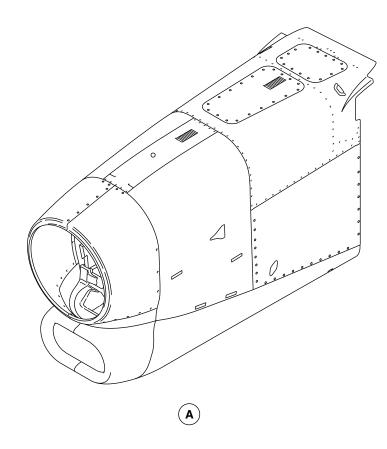
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Forward Nacelle Locator Figure 3

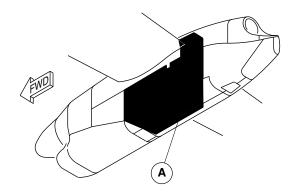
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NOTE

Right Nacelle Shown. Left Nacelle Similar.

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Centre Nacelle Frame Locator Figure 4

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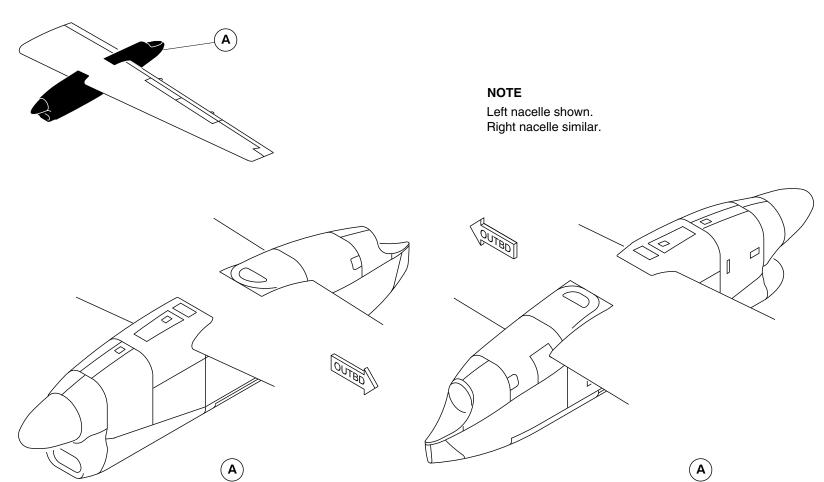
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Aft Nacelle Cowls Locator Figure 5

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# 54-10-00-001 FORWARD NACELLE

#### Introduction

The nacelle encloses the engine mounting structure that supports the propeller, gearbox, engine, systems and cowlings. Engine operating and aerodynamic loads are transferred through the structure to the nacelle centre section and wing box.

### **General Description**

### Refer to Figures 1 and 2.

The forward nacelle extends forward from the wing front spar frame and contains the main support structure for the propulsion system.

The Forward Nacelle has the components that follow:

- Forward Nacelle Access Panels (54–11–00)
- Forward Nacelle Fairings (54–12–00)
- Forward Nacelle Struts (54–13–00).

Engine torque is transferred to the forward frame by the Hydraulic Torque Compensation System.

The forward frame is designed to redistribute loads in the event of a mount or strut failure.

The struts distribute the load from the forward frame through the mid frame to the centre section and wing box using fittings and bolted

joints. The mid frame also supports the rear of the engine through the two aft elastomeric vibration isolator mounts.

The forward frame has the interfaces that follow:

- Engine vibration isolators
- Hydraulic torque compensation system
- Three strut attachment brackets.
- Ground support engine hoist bracket
- Lower cowling attachment
- Eight engine bonding leads
- Upper forward cowling location pin
- Spine attachment
- Electrical loom attachments
- Side door stay attachment
- Engine and accessories clearance.

The mid frame is used to attach the rear engine mounts and distribute the loading from the engine and propeller. It is a machined titanium frame and has the interfaces that follow:

- Engine aft vibration isolators
- Pneumatic pre-cooler and two valves
- Airframe de-ice attachment
- Fuel feed and motive flow line terminations
- Hydraulic feed, return and case drain line terminations
- Fire extinguisher line terminations

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- Harness clipping
- Strut fittings
- Lower cowl connection
- Leading edge fairing connection
- Spine connection
- Forward door interface and door stay latch
- Aft door attachment
- DC fault current ground lead.

#### **Detailed Description**

#### Refer to Figures 3 and 4.

The engine mounting structure has a forward frame (Horse Collar) which supports the engine through three elastomeric vibration isolator mounts, to transfer the loads from the propeller and engine into the struts through strut fittings. The frame is a machined titanium section with an integral Warren Girder web stiffening section, that is installed perpendicular to the engine axis, and is located external of the engine rotor burst zone.

The engine isolation system has five mounts:

- Three located on the forward face of the forward frame
- Two located on the aft face of the mid frame.

The five mounts are elastomeric and help reduce the transmission of propeller vibrations to the cabin interior. The isolation system limits maximum engine deflections, and provides isolation under normal operation.

The torque restraint system has two interconnected opposite acting actuators, that are attached through a linkage mechanism to the forward side mount engine attachment brackets. The system is self contained, designed to replenish and bleed itself, and contains approximately 12 in³ (197 mm³) of MIL–H–5605 hydraulic fluid. The cylinders and fluid lines are manufactured from stainless steel and the reservoir is aluminum alloy. In the event of a failure of the torque reaction system, the side mounts will snub and react to torque.

#### **Forward Nacelle Access Panels**

#### Refer to Figures 5 and 6.

The upper forward cowl is manufactured from carbon epoxy composite, with copper mesh High Intensity Radio Frequency (HIRF) and Lightning protection provided on the outer surface. The cowl is attached using quick release fasteners at the bottom edge, with a location pin at the top center line position. The cowl is sealed on its aft and lower edges using a non–conductive elastomer seal bonded in place.

The upper forward cowl is removed to access the items that follow:

- Propeller back plate
- Brush blocks
- Engine mounts
- Torque reaction system
- Removal of the lower cowl.

## Refer to Figures 7, 8 and 9.

The left and right forward doors are made from carbon epoxy composite with integral foam filled stiffening ribs. HIRF and lightning

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strike protection is provided using copper mesh on the outer surface of the doors. The doors are attached to the upper spine member, have a stay strut at each end and are fastened closed by five quick release pin latches. The left door has provision for ventilation by a NACA duct manufactured from carbon epoxy and bonded to the door inner skin. The right door has an inlet and outlet for the starter generator cooling.

## Refer to Figure 10.

The left and right aft doors are made from a titanium fabricated construction, with a flat outer skin and Z shaped vertical stiffeners on the inner surface. The doors are attached on the aft edge with a door open restraint on the nacelle center section. The door is fastened closed using quick release fasteners on three edges.

The left door has an outlet grille for ventilation of the upper equipment bay. A ventilation duct is installed down the firewall and ends in a P seal to give a sealed interface when the door is closed. The lower stiffener of the door has drain holes to release leaked fluid overboard to the lower cowl drain lines. The hinged aft edge of the door is sealed to prevent fluid leakage.

### Refer to Figures 11 and 12.

The spine is located on the nacelle top center line, installed between the front and mid frames, and is made from fabricated titanium with three hinge points for forward doors attachment. The spine does not carry primary structural loads, but will carry aerodynamic loading in flight. The spine acts as a hinge beam for the forward doors, and gives an attachment point and exhaust outlet for the pneumatic system precooler. The Propeller Electronic Controller (PEC) is also installed on the spine.

The leading edge fairing is made from carbon epoxy composite with foam stiffening. Copper mesh on the outer surface gives HIRF and lightning strike protection. The fairing has an access panel for access to the upper area of the zone, and leading edge bay for maintenance.

13, 14, 15, 16, and 17.

The lower cowl is the only primary structural cowl, and serves as a partial load path for propulsion and inertial loads during normal operating conditions. In the event of primary structural element failure, the lower cowl is designed to transfer loads to the wing box.

The lower cowl is an aerodynamic fairing manufactured from titanium and carbon fiber. It provides an alternative load path in case of failure within the engine mount system. It is attached to the nacelle by hinges and latches.

The lower cowl has three frames located at the major load points. These frames are contoured to match the aerodynamic shape of the cowl. The forward frame is manufactured from two titanium and two aluminum alloy sections. The mid frame is manufactured from three aluminum alloy sections, while the aft frame is a single titanium machining.

The external skin and intake duct are molded in a carbon fibre/nomex honeycomb to form the aerodynamic surface of the cowl.

The fire floor is an assembly of machined and fabricated titanium components. It attaches to the frames and skin and provides additional stiffness. The air intake is integral to the cowl and is manufactured from a fireproof monolithic laminate.

The fire floor forward access—panel is installed in the forward nacelle at the forward edge of the lower cowl. The fire floor aft access—panel is installed in the forward nacelle at the middle of the lower cowl.

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Two nacelles de-icing boots (one per nacelle) form the air intake lips to remove ice buildup. The air for the nacelles de-icing boots is independently supplied.

The lower cowl floor provides a natural downward flow path for fluids towards the aft end of the nacelle. At the aft end of the floor a drain sump is located spanning the width of the nacelle. Bulk drains are provided at this location to allow fast and safe dispersion of the leaked fluid through the drain mast.

The forward inlet–duct drain holes are located in the lower nacelle acoustic liner. The drain holes are in the bottom surface of the engine inlet duct (between the de–icing boot and the cowl seam).

The lower cowl of each nacelle also has a Foreign Object Damage (FOD) outlet.

#### **Forward Nacelle Struts**

The space frame strut configuration for the engine mounting structure gives:

- Structural redundancy
- Rotor burst and damage tolerance
- Lateral stiffness
- Weight
- Access for maintenance.

The struts are made from machined and forged stainless steel with fork attachments at both ends.

The strut fittings are machined titanium construction with provision for bolt attachment to the forward and mid frame positions. The

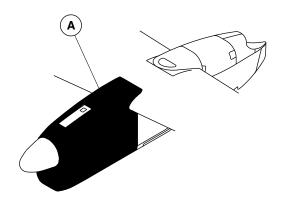
fittings are located at three locations on the aft face of the forward frame, and at the forward and aft face of the mid frame. The fittings are attached to the frames by bolted connection, and the strut bolt connections to the fittings are bushed.

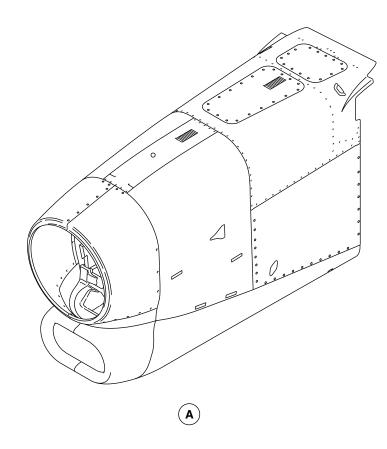
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Forward Nacelle Locator Figure 1

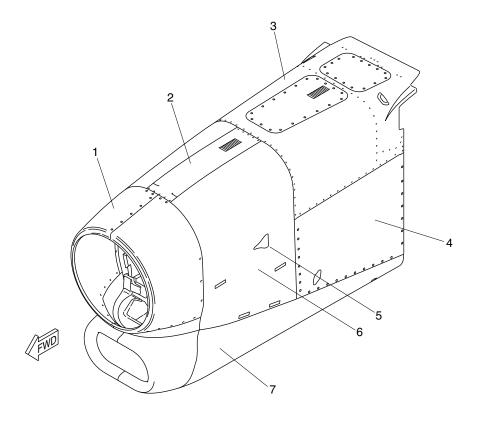
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#### **LEGEND**

- 1. Forward Cowl Assembly.
- 2. Spine Cowl Assembly.
- Leading Edge Fairing Assembly.
   Aft Door Assembly.
- 5. NACA Vent.
- 6. Forward Door Assembly.7. Lower Cowl Assembly.

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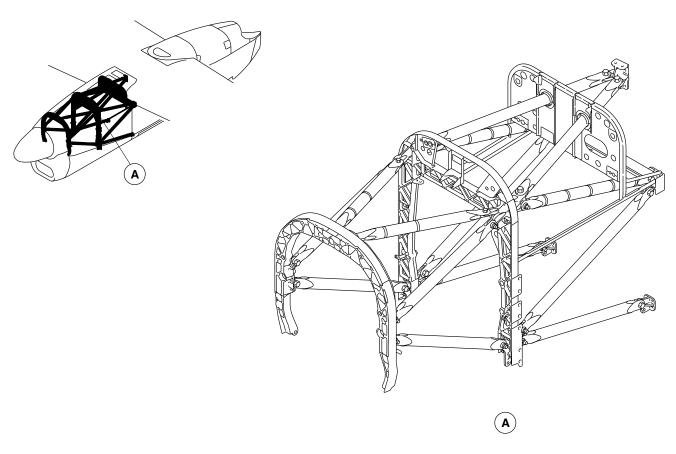
Forward Nacelle Detail Figure 2

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Nacelle Support Frames and Struts Location Figure 3

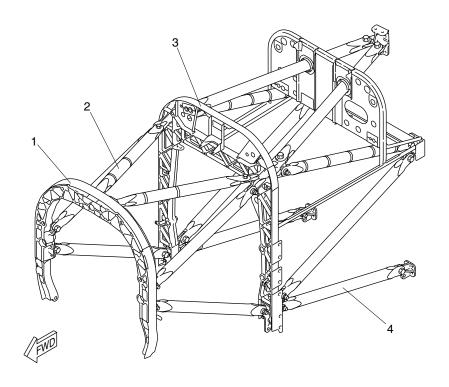
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#### **LEGEND**

- 1. Forward Frame.
- 2. Forward Strut.
- 3. Mid Frame.
- 4. Aft Strut.

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Nacelle Support Frames and Struts Detail Figure 4

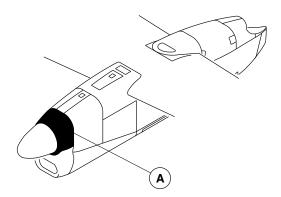
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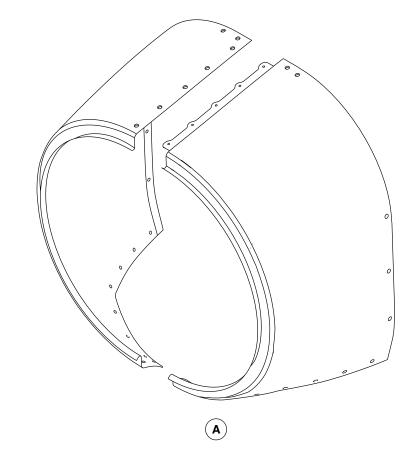




#### NOTE

Left nacelle shown. Right nacelle similar.





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Forward Cowls Locator Figure 5

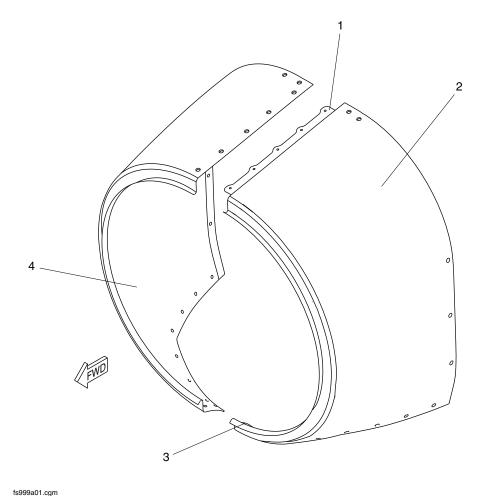
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### **LEGEND**

- Top Strap.
   Left Cowl.
- 3. Bottom Strap. 4. Right Cowl.

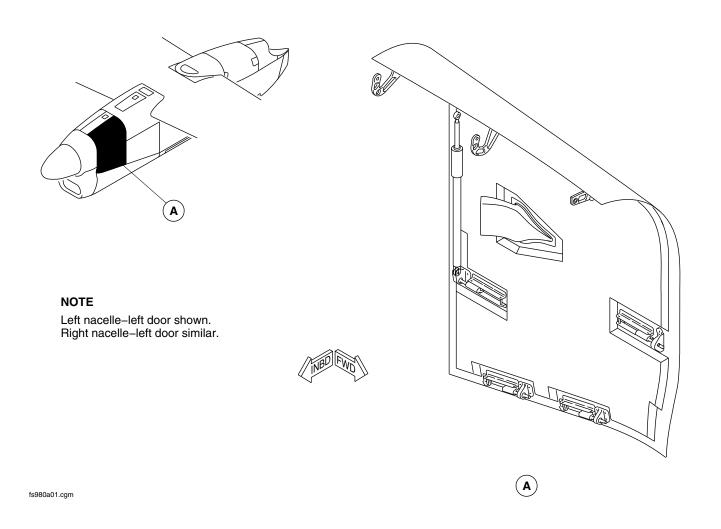
Forward Cowls Detail Figure 6

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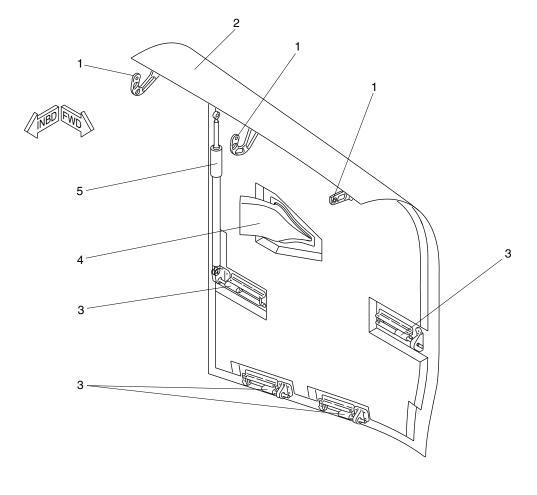
Nacelle Left Forward Door Locator Figure 7

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#### **LEGEND**

- 1. Hinge. 2. Left Door.
- 3. Latch.
- 4. NACA Vent.
- 5. Locking Strut.

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Nacelle Left Forward Door Detail Figure 8

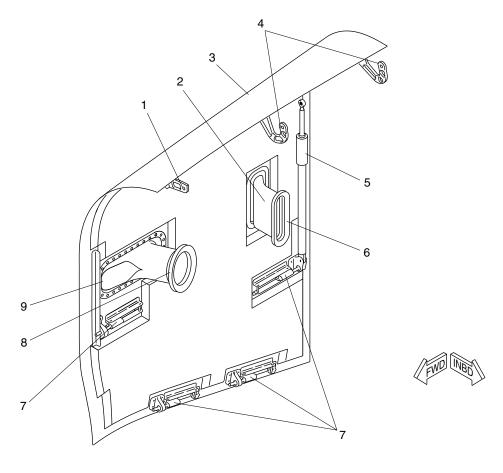
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#### **LEGEND**

- Hinge.
   D.C. Outlet Duct.
   Right Door.
- 4. Hinge. 5. Strut.
- 6. D.C. Outlet Duct Seal.
- 7. Latch.
- 8. D.C. Inlet Duct Seal.
- 9. D.C. Inlet Duct.

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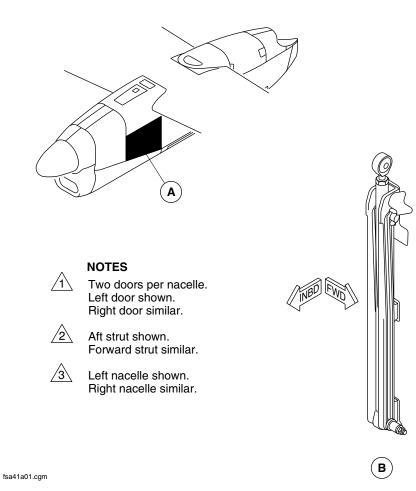
Nacelle Right Forward Door Detail Figure 9

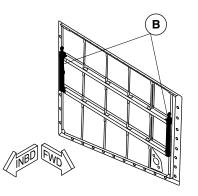
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A NACELLE DOOR ASSEMBLY

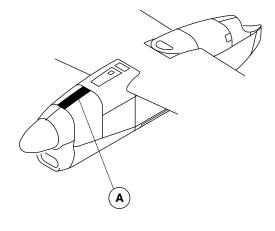
Nacelle Side Doors Figure 10

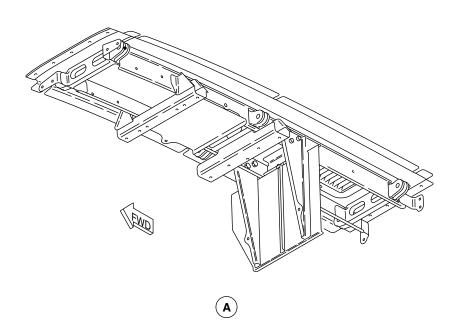
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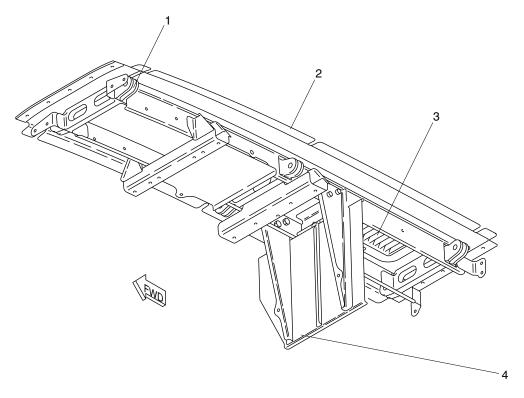
Spine Cowl Locator Figure 11

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#### **LEGEND**

- Typical Hinge.
   Spine Cowl.
   Louvre.

- 4. Pre-Cooler Heat Shield Assembly.

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Spine Cowl Detail Figure 12

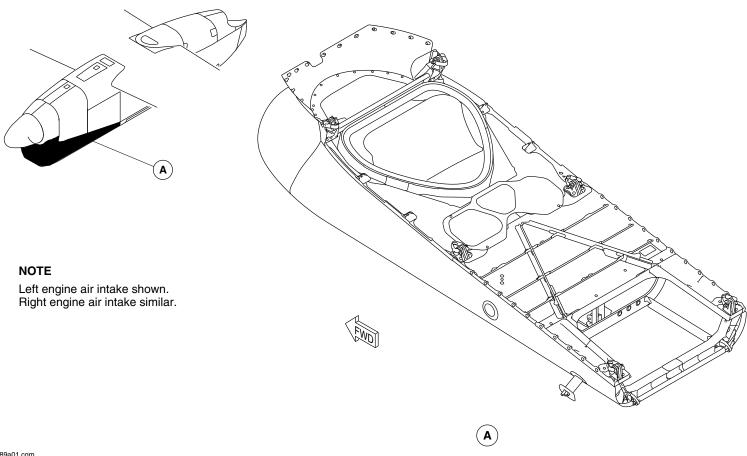
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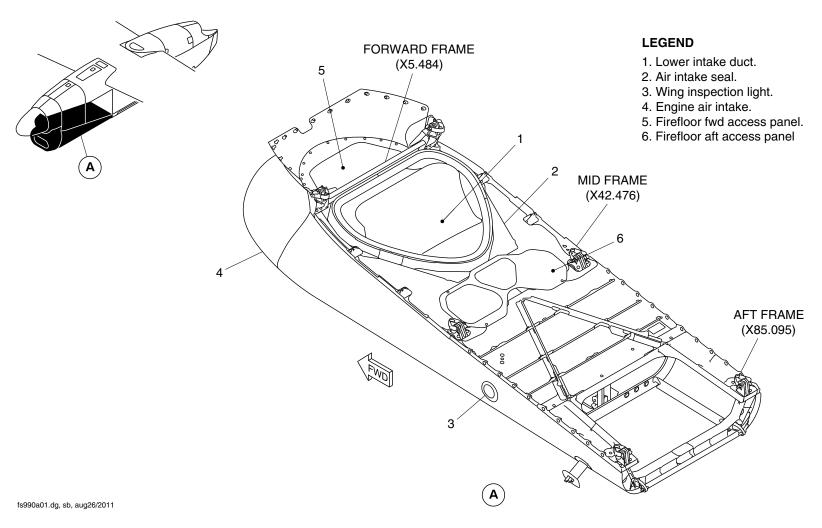
Lower Cowl Location Figure 13

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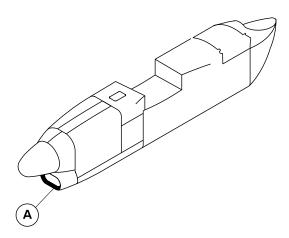
Lower Cowl Detail Figure 14

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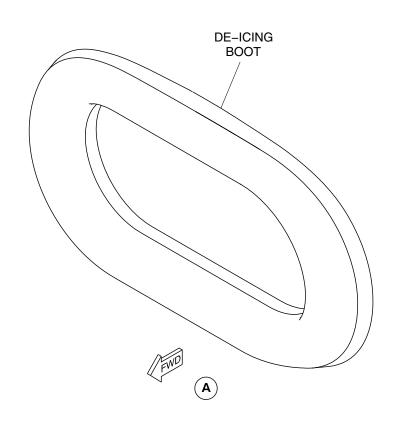
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#### NOTE

Left side shown. Right side similar.



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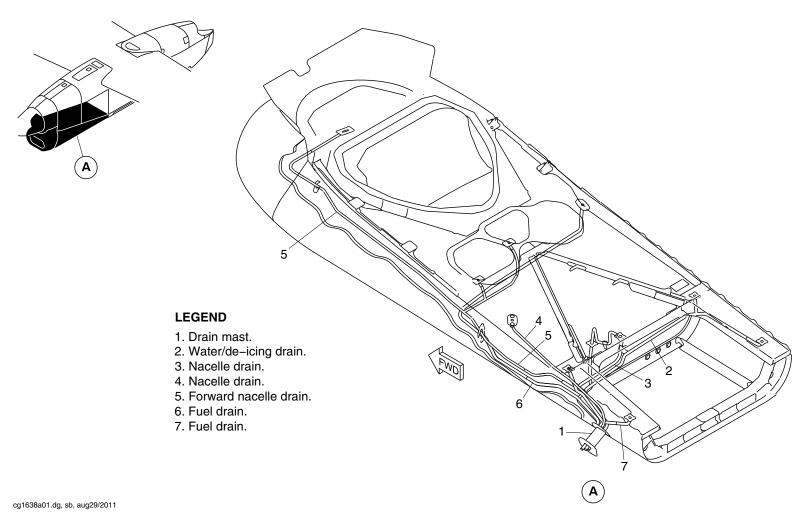
Nacelle De-icing Boots Figure 15

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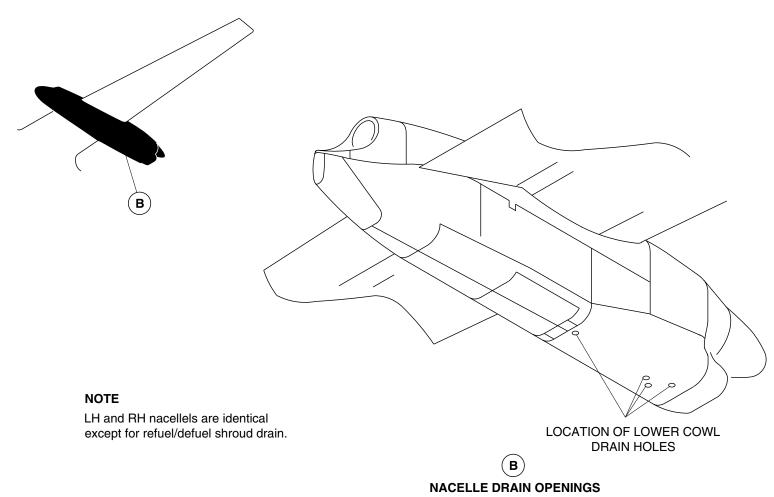
Fwd Nacelle – Lower Cowl Drain Installation Figure 16 (Sheet 1 of 2)

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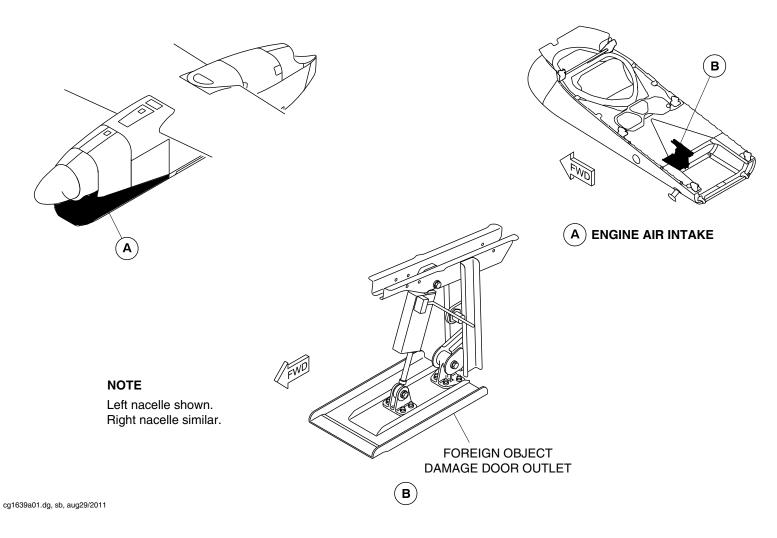
Fwd Nacelle – Lower Cowl Drain Installation Figure 16 (Sheet 2 of 2)

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Foreign Object Damage (F.O.D) Door Outlet
Figure 17

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#### 54-20-00-001

## **CENTER NACELLE**

#### Introduction

The nacelle centre section houses the main landing gear and wing nacelle attachments points.

### **General Description**

The nacelle center section extends from the nacelle forward section to the lower aft section.

The nacelle centre section, has the components that follow:

- Main Side Panels
- Main Landing Gear A Frame
- Wing Front and Rear Spar attachments
- Firewall and Oil Cooler Support Structure
- Nacelle Centre Access Panels (54–21–00).

## **Detailed Description**

Refer to Figures 1 and 2.

#### **Main Side Panels**

The side structure of the nacelle centre section has upper and lower aluminium alloy outer skins and is attached to the wing lower skin by drag angles. The main landing gear door opening is provided by carbon epoxy sandwich construction, lower side panels attached to lower longerons with a closing aluminium alloy web, form a box section construction.

#### Main Landing Gear 'A' Frame

The main landing gear "A" frame is machined from solid aluminium alloy and is attached to the wing front spar, upper longeron and the forward nacelle mid-struts.

The bottom of the main landing gear drag strut and side braces are attached to the lower longerons, forward nacelle lower struts with back-up fittings and a shear deck. Support structure is included for the firewall and oil cooler suspension. There are two titanium non-firewalls spaced 1.3 in. (33 mm) apart to create ventilation zone 4, with an inlet for airflow to supply the exhaust forward ejector.

## Firewall and Oil Cooler Support Structure

The oil cooler is installed to a fixed structure at the lower section of the firewall. The mounting structure has two aluminium alloy machined ribs with a shear diaphragm on top. The side ribs also include the forward lower hinge tracks. The back—up structure for the oil cooler is covered by a removable horizontal titanium fire floor, which is sealed against the forward, lower cowl fire door.

## Wing Front and Rear Spar Attachments

The wing rear spar attachments to the nacelle have two fittings machined from aluminium alloy. The attachments supply nacelle to wing, main landing gear yoke and coat hanger interfaces. The attachment fittings are attached to the longerons and mounted off the rear spar. The coat hanger is also attached to the rear spar at its

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mid-point. The wing front spar attachment is through the A frame integral lugs, with forward and aft, steel fittings, for multi-load path.

#### **Nacelle Centre Access Panels**

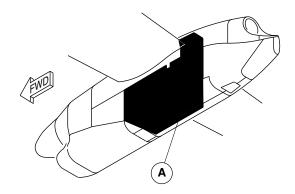
The nacelle centre access panels give access for maintenance tasks and are machined from aluminium alloy. There are access panels for the wing front and rear spar attachments and the forward exhaust attachments.

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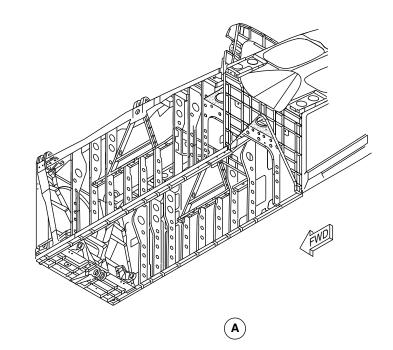




NOTE

Right Nacelle Shown. Left Nacelle Similar.

fs319a01.cgm



Centre Nacelle Frame Locator Figure 1

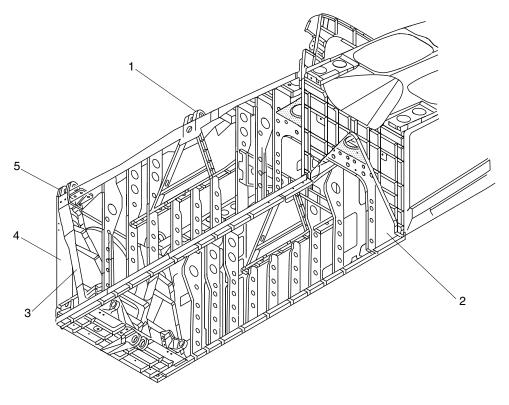
PSM 1-84-2A EFFECTIVITY:

See first effectivity on page 2 of 54-20-00 Config 001

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#### **LEGEND**

- 1. Wing Rear Spar Attachment.
- 2. Main Side Panel.
- Main Landing Gear 'A' Frame.
   Firewall and Oil Cooler Support Structure.
   Wing Front Spar Attachment.

fs320a01.cgm

Centre Nacelle Frame Detail Figure 2

PSM 1-84-2A EFFECTIVITY:

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#### 54-21-00-001

## **CENTER NACELLE ACCESS PANELS**

#### Introduction

The access panels can be removed to do inspection and maintenance tasks.

#### **General Description**

### Refer to Figures 1 and 2.

There are six access panels on the nacelle centre structure.

The nacelle centre structure has the access panels that follow:

- 2 Rear Spar Access Panels
- 2 Front Spar Attachment Access Panels
- 2 Forward Exhaust Attachments Access Panels.

## **Detailed Description**

## **Rear Spar Access Panel**

These access panels are machined from solid aluminium alloy. The access panels have sixteen countersunk holes and are attached to the nacelle centre structure. The panels are removed to gain access to the rear spar attachments.

### **Front Spar Attachment Access Panel**

These access panels are machined from solid aluminium alloy.

The access panels have thirteen countersunk holes and are attached to the nacelle centre structure with bolts. The panels are removed to gain access to the forward spar attachments.

#### Forward Exhaust Attachments Access

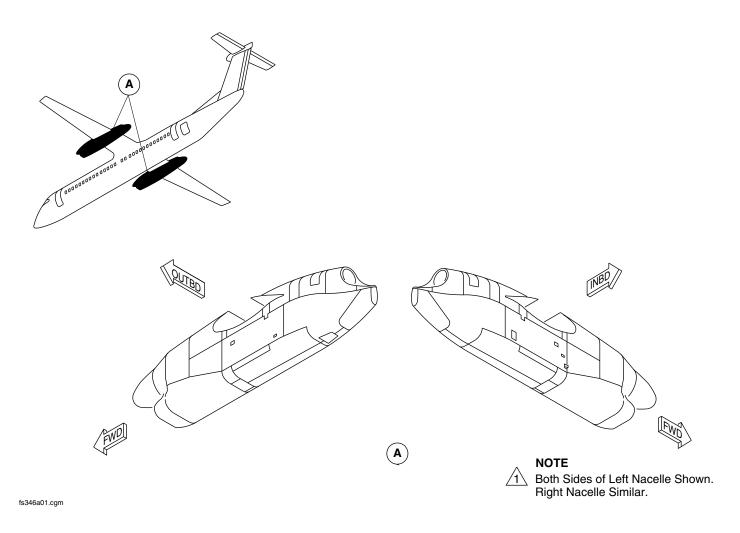
The access panels are machined from solid aluminium alloy. The inboard access panels have thirteen holes and are attached to the nacelle centre structure with bolts. The panels are removed to gain access to the forward exhaust attachments.

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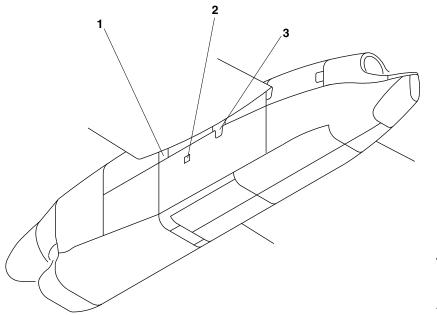
Spar/Forward Exhaust Access Panels Locator
Figure 1

PSM 1–84–2A EFFECTIVITY: See first effectivity on page 2 of 54–21–00 Config 001

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## **LEGEND**

- 1. Front Spar Access Panel.
- 2. Forward Exhaust Access Panel.
- 3. Rear Spar Access Panel.

NOTE



Left Side Of Nacelle Shown. Right Side Similar.



Left Nacelle Shown. Right Nacelle Similar.

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Spar/Forward Access Panels Detailed Figure 2

PSM 1-84-2A **EFFECTIVITY**: See first effectivity on page 2 of 54-21-00

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# **AFT NACELLE**

54-30-00-001

#### Introduction

The nacelle aft section houses part of the exhaust assembly, and the main landing gear wheels when it is retracted. It includes the structure of the lower fairing and the forward and aft upper fairings.

## **General Description**

The nacelle aft section has the parts that follow:

- Nacelle Aft Access Panels (54–31–00)
- Nacelle Aft Fairings and Surfaces (54–32–00).

### **Nacelle Aft Access Panels**

1, 2, and 3.

The nacelle aft access panels/doors are removed/opened to do maintenance tasks and inspections. There are three access panels in each nacelle aft section. The two aft exhaust trunnion access panels are located on each side of the nacelles. They gives access to the trunnion bearing. In each engine nacelle, the aft upper inboard area is installed with a flap access panel. The flap access panel gives the access to the inspection and maintenance of the flap—track mounting structure. An access door is installed on the bottom of the right aft nacelle. It gives access to the fueling control panel.

# **Nacelle Aft Fairings and Surfaces**

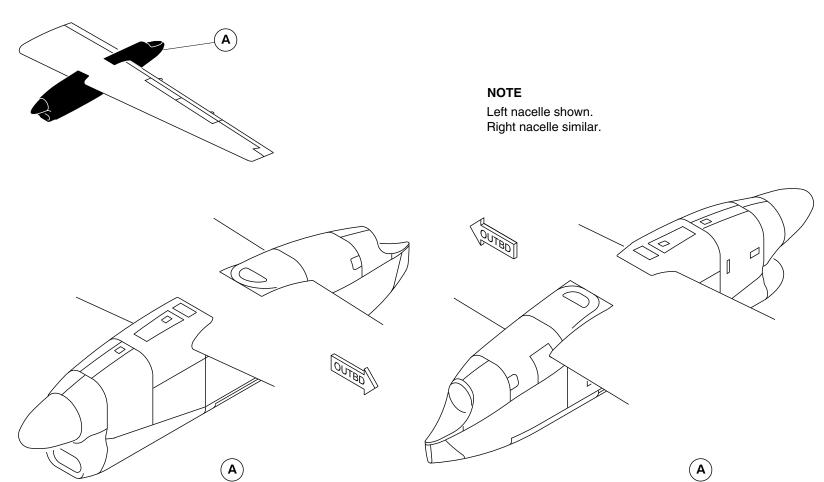
The function of the nacelle aft fairings is to make an aerodynamic surface. They also house the aft part of the engine exhaust and the retracted MLG wheels. The nacelle aft top fairings can be removed to give access to the engine exhaust.

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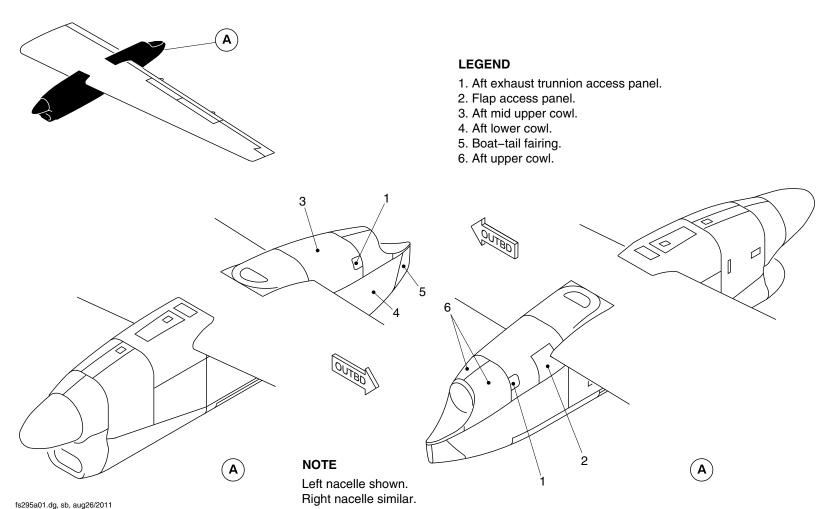
Aft Nacelle Cowls Locator Figure 1

PSM 1–84–2A EFFECTIVITY: See first effectivity on page 2 of 54–30–00 Config 001

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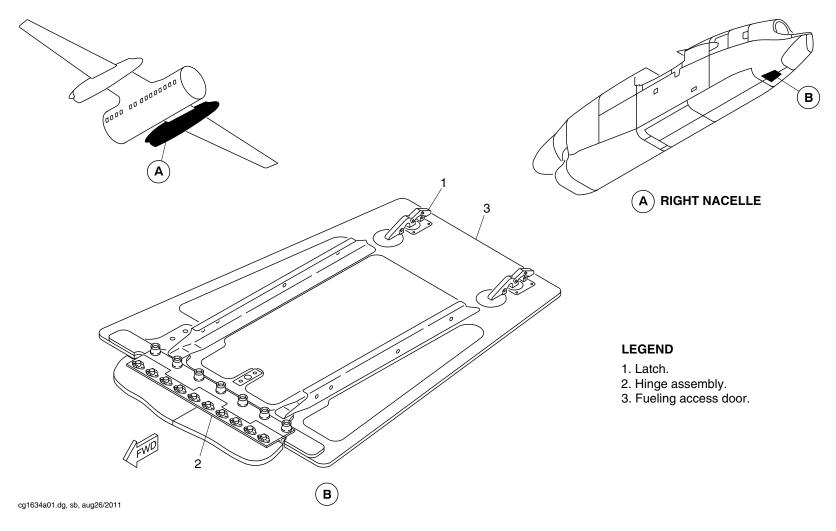
Aft Nacelle Cowls Detailed Figure 2

PSM 1–84–2A EFFECTIVITY: See first effectivity on page 2 of 54–30–00 Config 001

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Fueling Access Door – Right Aft Nacelle Figure 3

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## 54-31-00-001

# **AFT NACELLE ACCESS PANELS**

#### Introduction

The nacelle aft access panels/door gives access to areas for inspection and maintenance tasks.

# **General Description**

There are three access panels in each nacelle aft section, and one access door in the right aft nacelle.

Each nacelle aft section has the access panels that follow:

- Aft Exhaust Trunnions Access Panels (54–31–01)
- Flaps Access Panel (54–31–06)
- Refuel/Defuel Panel Access Door (Right Nacelle) (52–44–01).

#### **Aft Exhaust Trunnions Access Panels**

#### 1, and 2

An access panel is installed on each side of the nacelle aft section at the mid upper position. The access panels are machined from solid aluminium alloy. The access panels have seven countersunk holes and are attached to the aft mid upper cowl and the nacelle aft structure with bolts.

# Flaps Access Panel

The access panel is installed on the inboard side of the nacelle aft section at the forward upper position. The access panel is machined from solid aluminium alloy. The access panel has 24 countersunk holes and is attached to the aft mid upper cowl and the nacelle aft structure with bolts.

## Refuel/Defuel Panel Access Door (Right Nacelle)

## Refer to Figure 3.

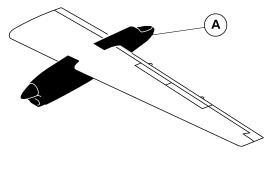
The access door is installed on the bottom of the right aft nacelle. The access door is machined from solid aluminium alloy. The access door opens out on a hinge at its forward edge, and latches in the closed position at two points on its rear edge. There are ten countersunk holes in the aft lower cowl for attachment by bolts to the access door hinge.

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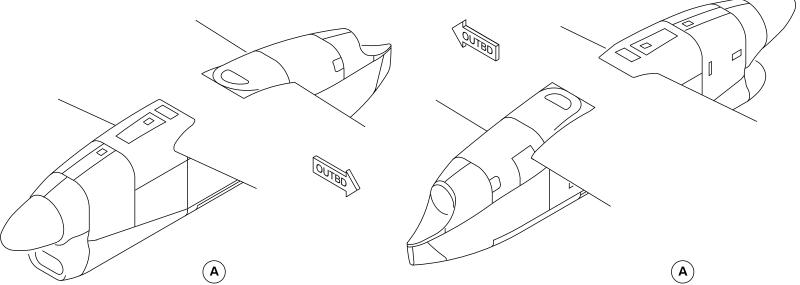
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# NOTE

Left nacelle shown. Right nacelle similar.



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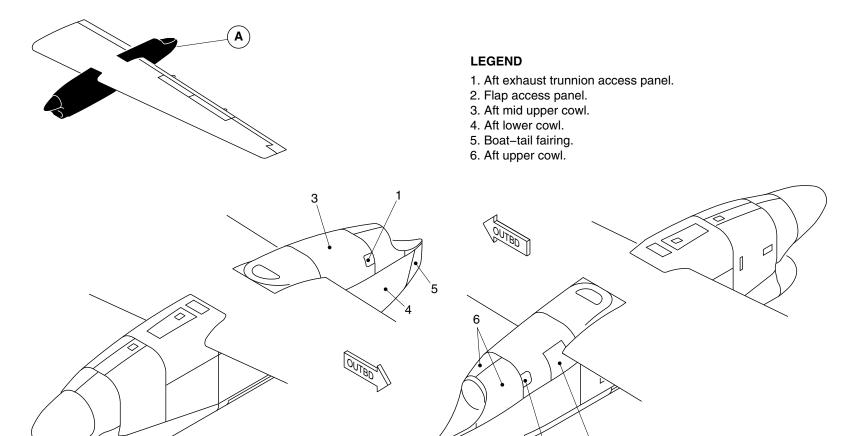
Aft Nacelle Access Panels Locator
Figure 1

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Aft Nacelle Access Panels Detail \_\_\_\_ Figure 2

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(A)

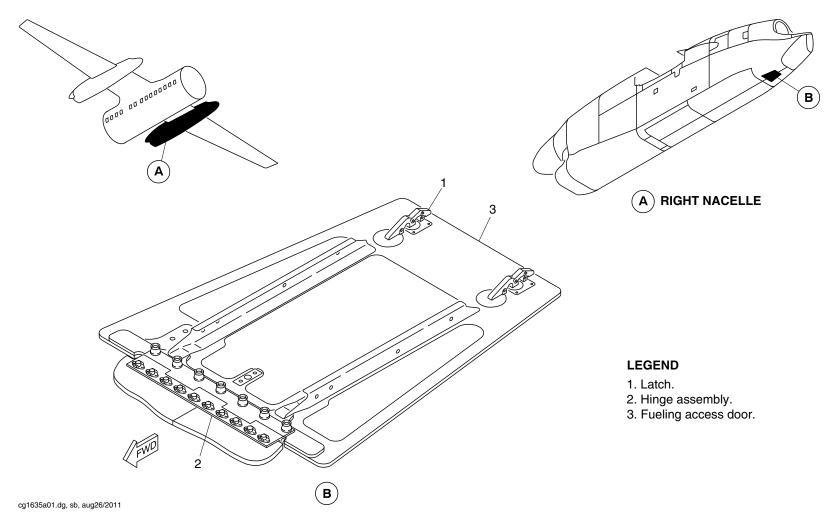
NOTE

Left nacelle shown. Right nacelle similar.

54-31-00

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Fueling Access Door – Right Aft Nacelle Figure 3

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## 54-32-00-001

# **AFT NACELLE FAIRINGS AND SURFACES**

#### <u>Introduction</u>

The nacelle aft fairings give an aerodynamic surface to the aft part of the engine exhaust and the retracted Main Landing Gear (MLG) wheels. The nacelle aft top fairings can be removed to give access to the engine exhaust.

# **General Description**

The nacelle aft section has fairings and surfaces in the areas that follow:

- Top Part of the Nacelle Aft Section
- Bottom Part of the Nacelle Aft Section.

# **Detailed Description**

Refer to Figures 1 and 2.

# **Top Part of the Nacelle Aft Section**

The top fairing is located above the aft exhaust assembly and has two parts:

- The aft mid upper cowl (forward part) is a 'U' shaped fairing made from carbon fibre/nomex honeycomb. It is attached at its forward end to an alloy frame at the rear of the nacelle center section.
- The aft upper cowl (aft part) has two skins made from fabricated aluminium alloy. This makes the opening at the rear for the aft exhaust outlet. The aft upper cowl gives a clearance around the aft exhaust outlet, which lets a secondary airflow decrease the exhaust temperature in the nacelle.

#### **Bottom Part of the Aft Nacelle**

The bottom part of the nacelle aft section has a large panel (aft lower cowl) on each side with a bulkhead that connects them at the mid point. They are made from carbon fibre/nomex honeycomb. Expanded copper foil is put in the outer surface of the aft lower cowl. The front end of the aft lower cowl makes the shape of a fairing for the retracted MLG wheel unit. The rear end of the aft lower cowl (right nacelle only) makes the shape of a fairing for a refuel/defuel adapter and control panel.

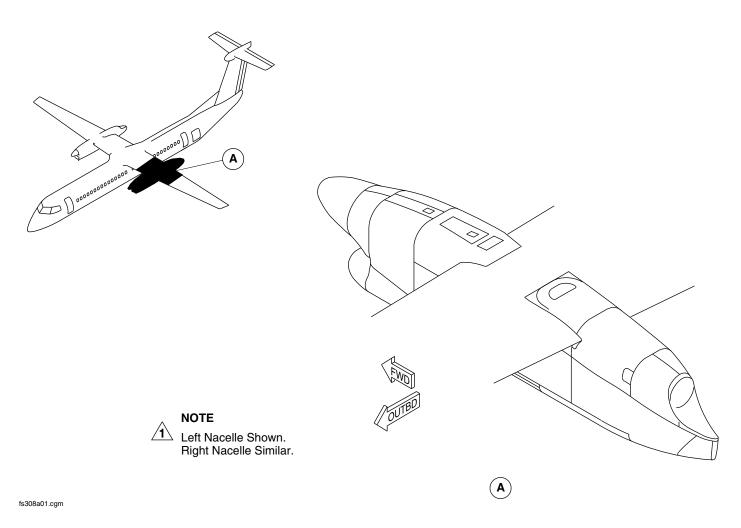
The aft lower cowl is closed at the rear end by the boat–tail fairing. The top of the aft lower cowl is closed by a heatshield. The heatshield is made from fabricated aluminium alloy, part of which is in the shape of the MLG wheels when in the retracted position.

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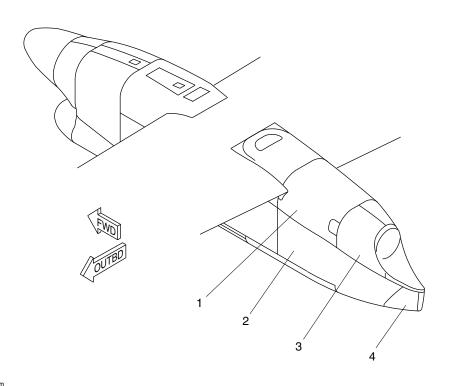
Aft Nacelle Fairings and Surfaces – Systems Description Section (1)
Figure 1

PSM 1–84–2A EFFECTIVITY: See first effectivity on page 2 of 54–32–00 Config 001

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#### **LEGEND**

- 1. Aft Mid Upper Cowl.
- 2. Aft Lower Cowl.
- 3. Aft Upper Cowl.
- 4. Boat-Tail Fairing.

NOTE

Left Side of Nacelle Shown. Right Side Similar.

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Aft Nacelle Fairings and Surfaces – Systems Description Section (2)
Figure 2

PSM 1-84-2A EFFECTIVITY:

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