CHAPTER

47

INERT GAS SYSTEM

CHAPTER 47
INERT GAS SYSTEM

Subject/Page	Date	COC
47-EFFECTIVE PAGES		
1 thru 3	Sep 05/2018	
4	BLANK	
47-CONTENTS		
1	May 05/2015	
2	Sep 05/2016	
3	May 05/2015	
4	BLANK	
47-00-00		
1	May 05/2015	
2	May 05/2015	
3	May 05/2015	
4	May 05/2015	
5	May 05/2015	
6	May 05/2015	
7	May 05/2015	
8	May 05/2015	
9	May 05/2015	
10	May 05/2015	
47-10-00		
1	May 05/2015	
2	May 05/2015	
3	May 05/2015	
4	May 05/2015	

Subject/Page	Date	COC
47-10-00 (cont.)		
5	May 05/2015	
6	May 05/2015	
7	May 05/2015	
8	May 05/2015	
9	May 05/2015	
10	May 05/2015	
11	May 05/2015	
12	May 05/2015	
13	May 05/2015	
14	May 05/2015	
15	May 05/2015	
16	May 05/2015	
17	May 05/2015	
18	May 05/2015	
19	May 05/2015	
20	May 05/2015	
21	May 05/2015	
22	May 05/2015	
23	May 05/2015	
24	May 05/2015	
25	May 05/2015	
26	May 05/2015	

A = Added, R = Revised, D = Deleted, O = Overflow, C = Customer Originated Change

47-EFFECTIVE PAGES

CHAPTER 47
INERT GAS SYSTEM

Subject/Page	Date	COC
47-10-00 (cont.)		
27	May 05/2015	
28	May 05/2015	
29	May 05/2015	
30	May 05/2015	
31	May 05/2015	
32	May 05/2015	
33	May 05/2015	
34	May 05/2015	
35	May 05/2015	
36	May 05/2015	
37	May 05/2015	
38	May 05/2015	
39	May 05/2015	
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41	May 05/2015	
42	May 05/2015	
43	May 05/2015	
44	May 05/2015	
45	May 05/2015	
46	May 05/2015	
47	May 05/2015	
48	May 05/2015	
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47-20-00		
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4	May 05/2015	
5	May 05/2015	
6	May 05/2015	

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47-EFFECTIVE PAGES

CHAPTER 47
INERT GAS SYSTEM

Subject/Page	Date	COC
47-20-00 (cont.)		
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4	May 05/2015	
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6	May 05/2015	
7	May 05/2015	
8	May 05/2015	
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10	May 05/2015	
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47-40-10 (cont.)		
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14	May 05/2015	
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A = Added, R = Revised, D = Deleted, O = Overflow, C = Customer Originated Change

47-EFFECTIVE PAGES

CHAPTER 47
INERT GAS SYSTEM

47-CONTENTS

CHAPTER 47
INERT GAS SYSTEM

47-CONTENTS

CHAPTER 47
INERT GAS SYSTEM

47-CONTENTS

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NITROGEN GENERATION SYSTEM - INTRODUCTION

Purpose

The Nitrogen Generation System (NGS) reduces the oxygen content of the air mixture in the center tank to a level which will not support combustion.

General

The system does these functions:

- Controls the air pressure into the system
- Changes the ozone in the air to oxygen
- Decreases the temperature of the air
- Removes contamination from the air
- Removes oxygen from the air
- Supplies nitrogen enriched air to the center tank
- Does a check of system performance.

The Nitrogen Generation System has these subsystems:

- Thermal Control Unit (TCU)
- Air Separation Unit (ASU)
- Nitrogen Enriched Air Distribution (NEADS)
- Control
- Indication

The TCU has components in the Left Forward Wing to Body Fairing Panel -191QL and the ECS Low Pressure Connection Door -196CR.

The ASU has components in the Right Forward Wing to Body Fairing Panel -192QR.

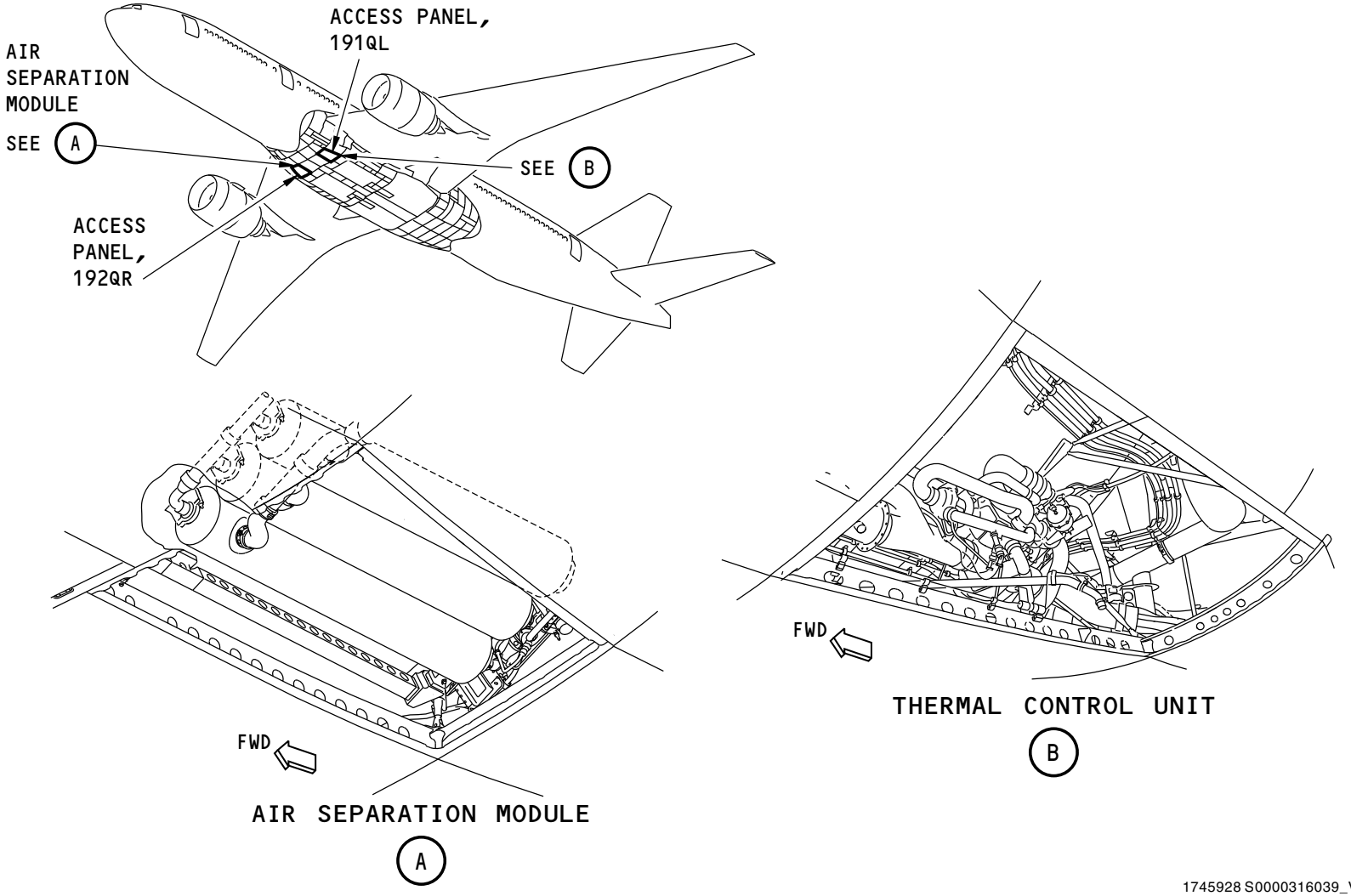
The NEADS has components in the Right Forward Wing to Body Fairing Panel -192QR, center wing tank, and left surge tank.

The controller is installed in the Forward Cargo Bay, on the right side.

The BITE display unit is found in the ECS Low Pressure Connection Door -196CR.

Abbreviations and Acronyms

- ASM - air separation module
- BDU - BITE display unit
- BITE - built in test equipment
- CWT - center wing tank
- GSE - ground support equipment
- NEA - nitrogen enriched air
- NEADS - nitrogen enriched air distribution system
- NGS - nitrogen generation system
- OEA - oxygen enriched air
- OTSOV - overtemperature shutoff valve
- RAV - ram air valve
- TCU - thermal control unit



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NITROGEN GENERATION SYSTEM

NITROGEN GENERATION SYSTEM - FUNCTIONAL DESCRIPTION

General

The nitrogen generation system uses bleed air from the left side of the pneumatic manifold. The NGS shutoff valve controls the airflow from the manifold. The NGS controller uses system pressure and voltage to control the NGS shutoff valve.

Operation

The nitrogen generation system gets bleed air from the left side of the pneumatic manifold. A sensor on the bleed air duct sends pressure data to the NGS controller. The controller adjusts the NGS shutoff valve. The NGS shutoff valve controls the pressure that comes into the system.

Bleed air goes through the ozone converter, which reduces the ozone content in the bleed air by catalytic conversion to oxygen. Ozone can decrease the performance and mechanical properties of the air separation module.

The heat exchanger uses ram air to decrease the bleed air temperature to 210 degrees F. The temperature control valve adjusts the quantity of bleed air that bypasses the heat exchanger. The temperature sensor sends temperature data to the controller. The controller adjusts the temperature control valve.

The filter removes contamination before the air goes into the air separation module. A differential pressure sensor monitors the filter.

The air separation module decreases the oxygen in the air below the quantity necessary to support combustion. The air separation module removes oxygen from the air and releases it overboard.

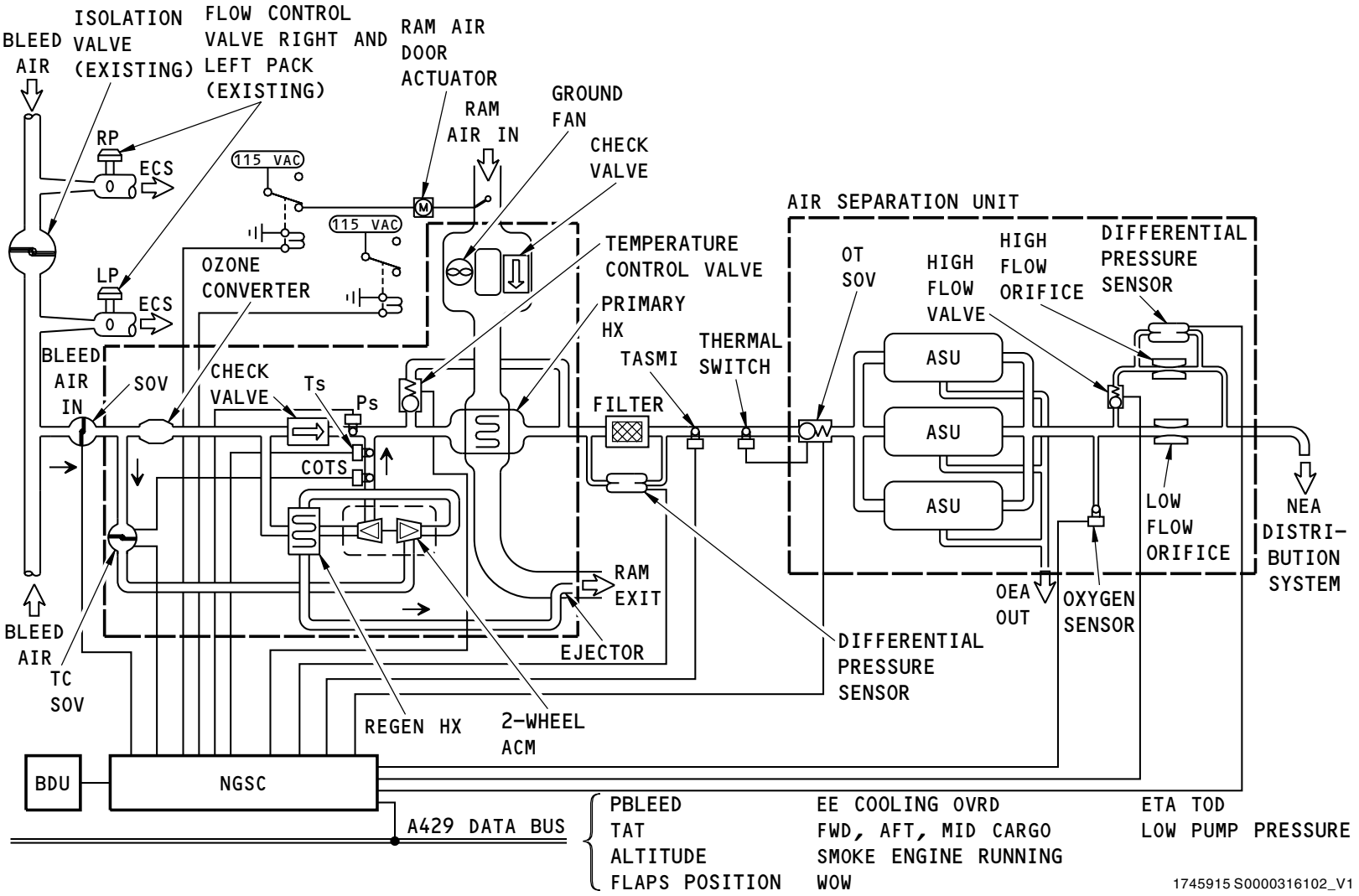
Nitrogen enriched air (NEA) goes through the high flow valve to the center tank. The high flow valve controls the quantity of NEA that goes to the center tank. The controller uses data from the differential pressure sensor and airplane systems to open or close the valve.

The NEA distribution system (NEADS) sends NEA to the center wing tank. NEA goes into the tank through an ejector nozzle in the right part of the tank. A float valve in the left part of the tank makes sure that the concentration of NEA is constant. A cross vent check valve makes sure that ambient air does not dilute the nitrogen concentration in the center tank during the descent.

The controller monitors and controls system operating temperatures and pressures.

You use the BITE display unit to do a test of the system.

You use the GSE connection to do a test of the oxygen quantity of the air downstream of the ASM.



NITROGEN GENERATION SYSTEM - FUNCTIONAL DESCRIPTION

NITROGEN GENERATION SYSTEM - COMPONENT LOCATION 1

Thermal Control Unit

These thermal control unit components are installed in the Left Forward Wing to Body Fairing Panel:

- Ozone Converter
- Heat Exchanger
- Ram Air Check Valve
- Temperature Control Valve
- Fan
- Regenerative Heat Exchanger
- Bleed Air Check Valve
- Turbo Compressor
- Turbo Compressor Shutoff Valve
- Thermal Switch
- Temperature Sensor
- Pressure Sensor

These thermal control unit components are in the Right ECS Low Pressure Connection Door:

- Filter
- Filter Differential Pressure Switch

The NGS shutoff valve is found in the Left ECS High Pressure Connection Door:

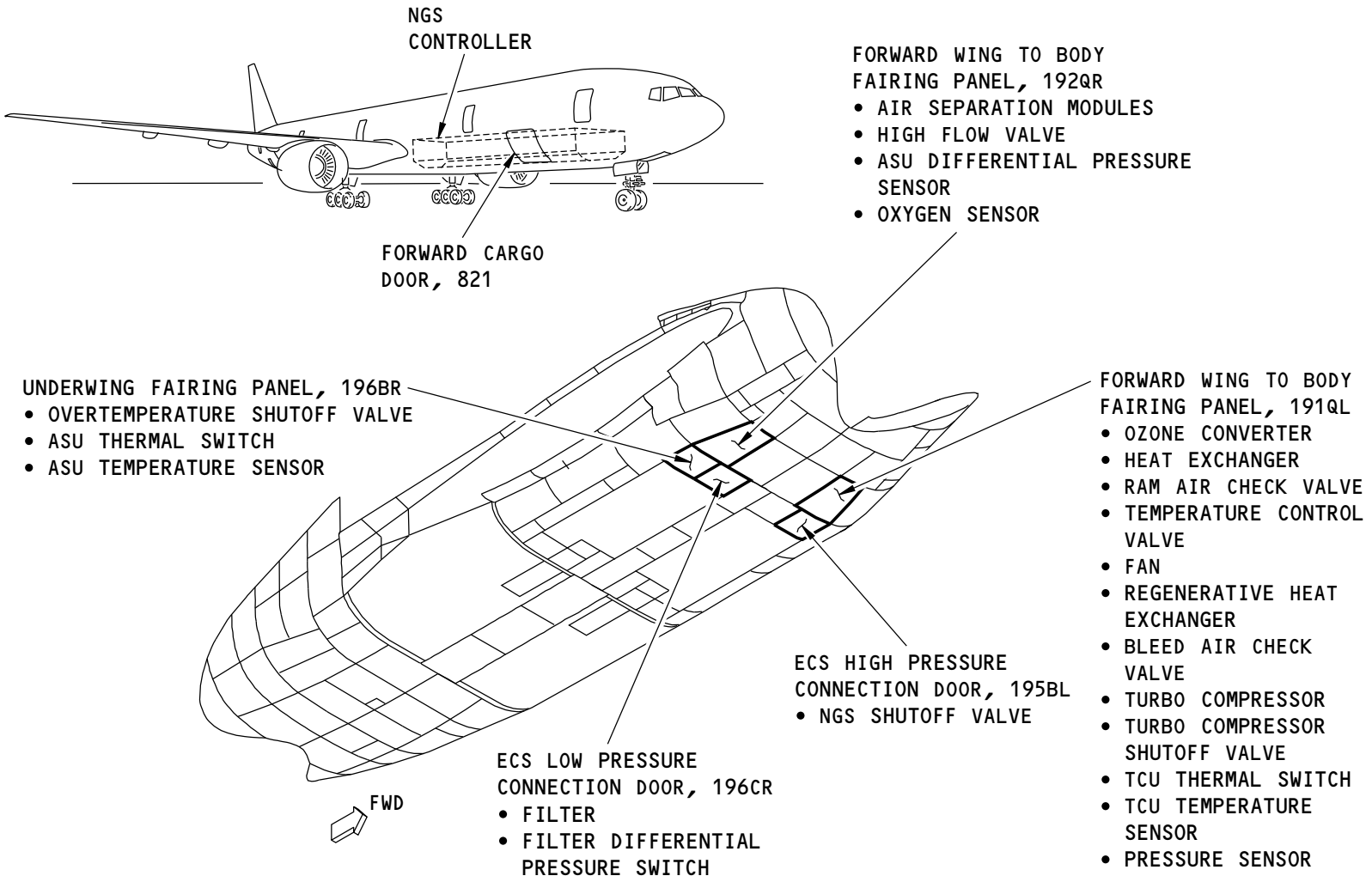
Air Separation Unit

These air separation unit components are found in the Right Forward Wing to Body Fairing Panel:

- Air Separation Modules
- High Flow Valve
- Differential Pressure Sensor
- Oxygen Sensor

These air separation unit components are found in the Right Underwing Fairing Panel:

- Overtemperature Shutoff Valve
- Thermal Switch
- Temperature Sensor



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NITROGEN GENERATION SYSTEM - COMPONENT LOCATION 1

NITROGEN GENERATION SYSTEM - COMPONENT LOCATION 2

NGS Control System

The NGS controller is installed in the forward cargo bay, on the right side. To get access to the NGS controller, open the forward large cargo door, 821.

BITE Display Unit

The BITE display unit is installed in the ECS Low Pressure Connection Door, 196CR.

Nitrogen Enriched Air Distribution System (NEADS) - Center Tank and Wing Structure

These NEADS components are found in the center tank::

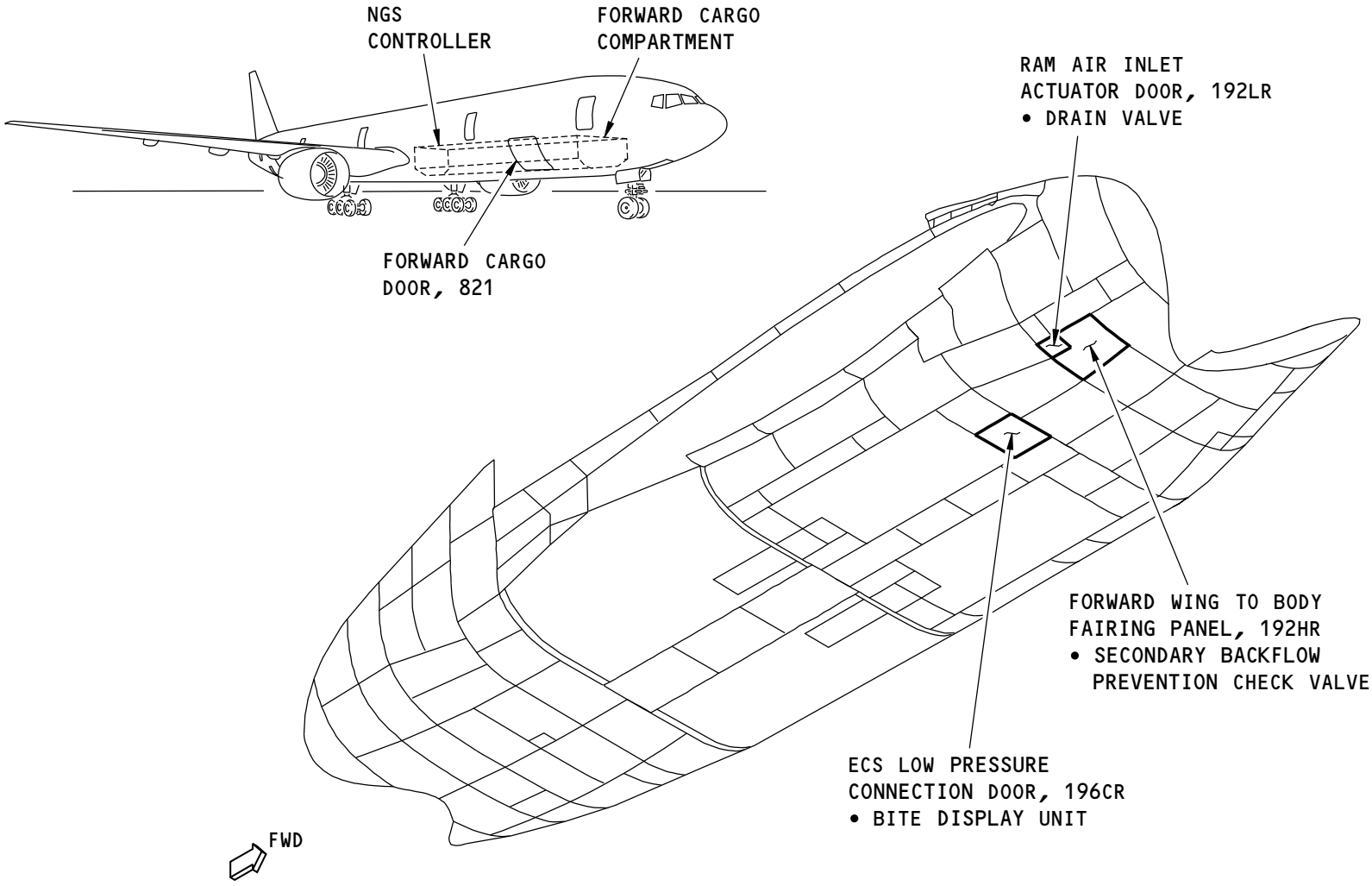
- Float Valve
- Primary Backflow Prevention Check Valve

The cross vent check valve is found in the left surge tank

Nitrogen Enriched Air Distribution System (NEADS) - Forward Wing to Body Fairing Panel

The drain valve is found above the Ram Air Inlet Actuator Door, 192LR.

The secondary backflow prevention check valve is found in the Forward Wing to Body Fairing Panel, 192HR



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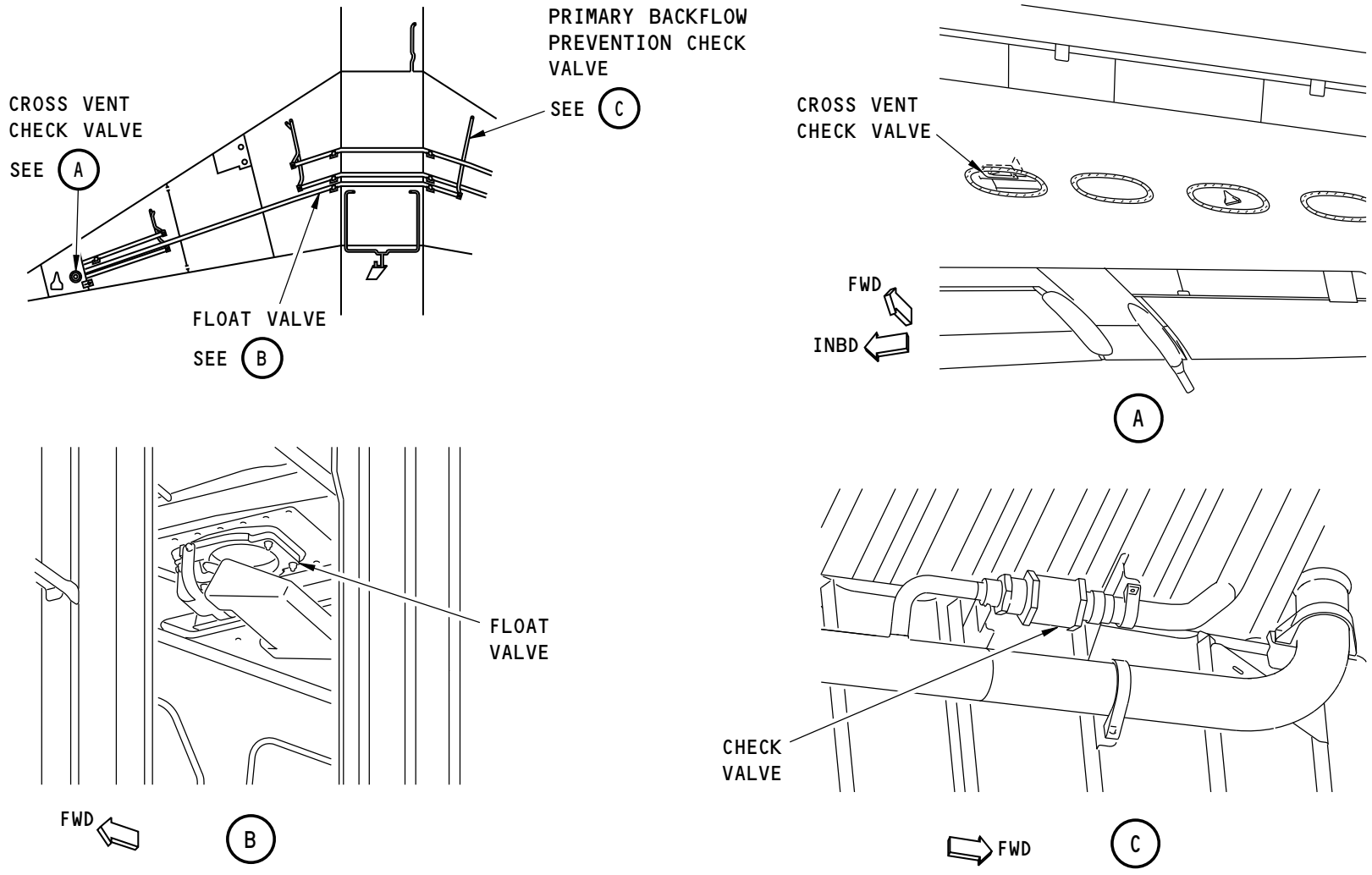
NITROGEN GENERATION SYSTEM - COMPONENT LOCATION 2



NITROGEN GENERATION SYSTEM - COMPONENT LOCATION 2

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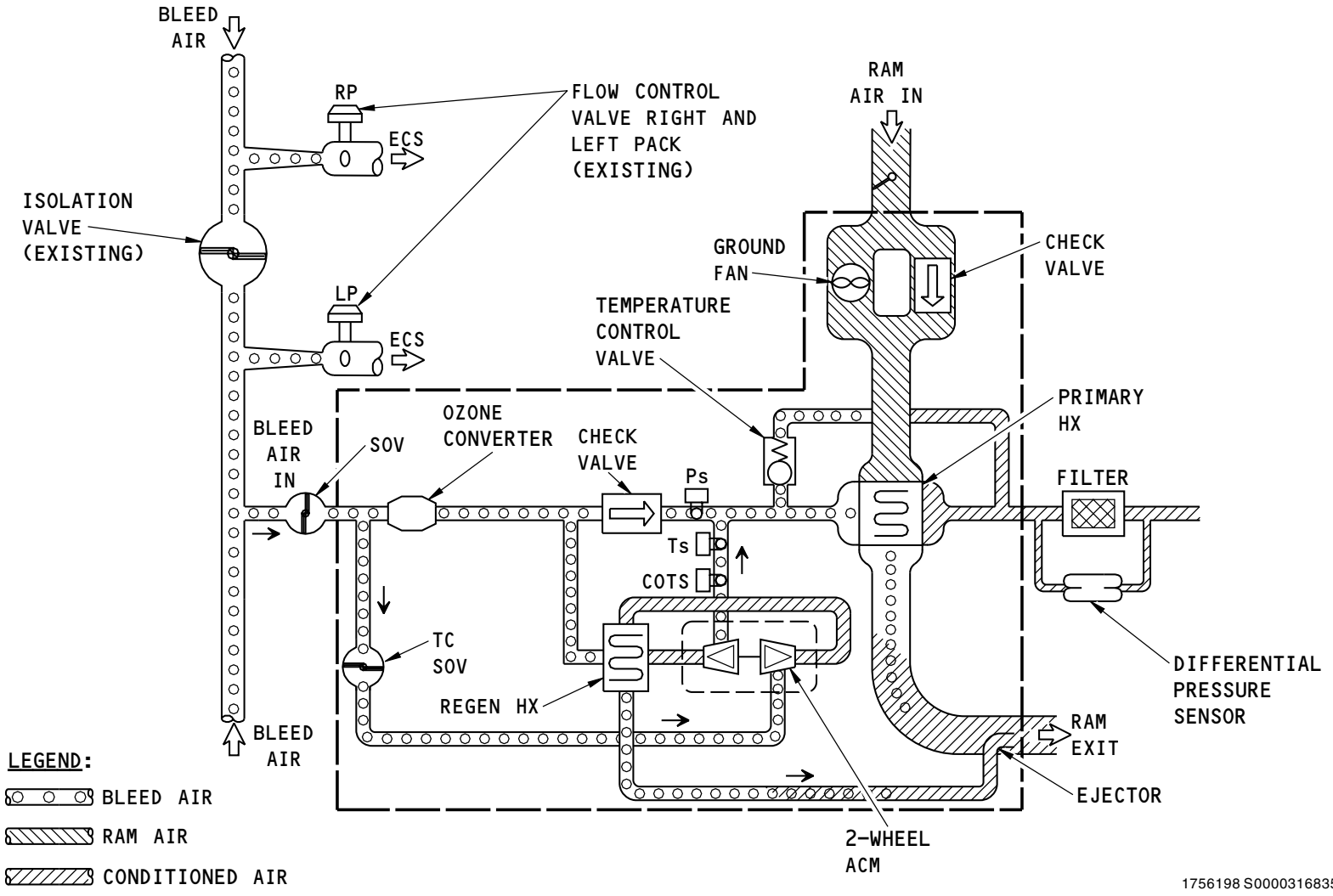
THERMAL CONTROL UNIT - INTRODUCTION

General

The Nitrogen Generation System (NGS) uses hot bleed air to make Nitrogen Enriched Air (NEA) for the center tank. The Thermal Control Unit (TCU) controls the bleed air pressure and temperature. The filter removes contamination that can damage the NGS and fuel system components. These are the components of the TCU:

- Nitrogen Generation System Shutoff Valve
- Ozone Converter
- Heat Exchanger
- Filter
- Ram Air Check Valve
- Temperature Control Valve
- Fan
- Regenerative Heat Exchanger
- Turbo Compressor
- Bleed Air Check Valve
- Turbo Compressor Shutoff Valve
- Filter Differential Pressure Sensor
- Thermal Control Unit - Thermal Switch
- Thermal Control Unit - Temperature Sensor
- Thermal Control Unit - Pressure Sensor



THERMAL CONTROL UNIT

NITROGEN GENERATION SYSTEM SHUTOFF VALVE

Purpose

The Nitrogen Generation System (NGS) shutoff valve controls bleed air flow for the NGS.

Location

The NGS shutoff valve is found aft of the Thermal Control Unit (TCU), between the bleed air inlet duct and the ozone converter, above the ECS High Pressure Connection Door, 195BL.

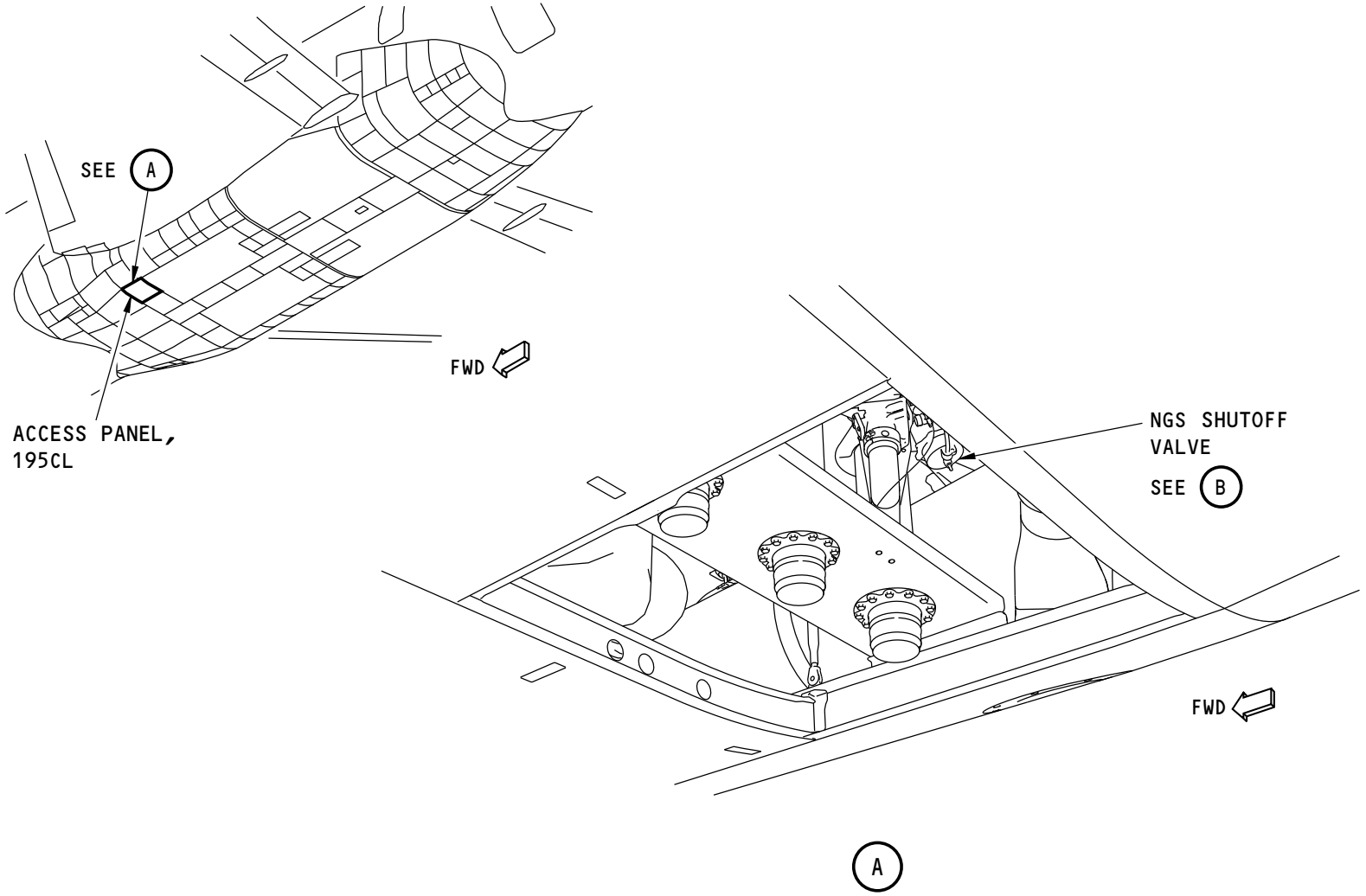
General Description

The NGS shutoff valve is a dual purpose pressure regulating and system shutoff valve. The NGS shutoff valve is a 2 in. (51 mm) diameter spring-loaded-closed valve. The NGS shutoff valve is pneumatically actuated and solenoid-controlled. The NGS shutoff valve will close when it is de-energized and open when energized. The NGS shutoff valve can also be manually wrenched closed and locked in the closed position. The NGS shutoff valve has an OPEN/CLOSED position indicator.

The NGS shutoff valve functions as an overpressure regulator in the event of a bleed air system pressure regulator failure. The NGS shutoff valve uses a spring-loaded-closed butterfly-type valve disc. The solenoid is actuated to the open position and will close when de-energized. The NGS shutoff valve opens and closes within 2 seconds.

The NGS shutoff valves has these functions:

- Regulate duct pressure to 61 ±6 psig (421 ±42 kPa) on the outlet side of the NGS shutoff valve when the inlet side duct pressure is more than 67 psig (462 kPa). The NGS shutoff valve is fully open up to 50 psig (345 kPa).
- Shutoff the NGS system.



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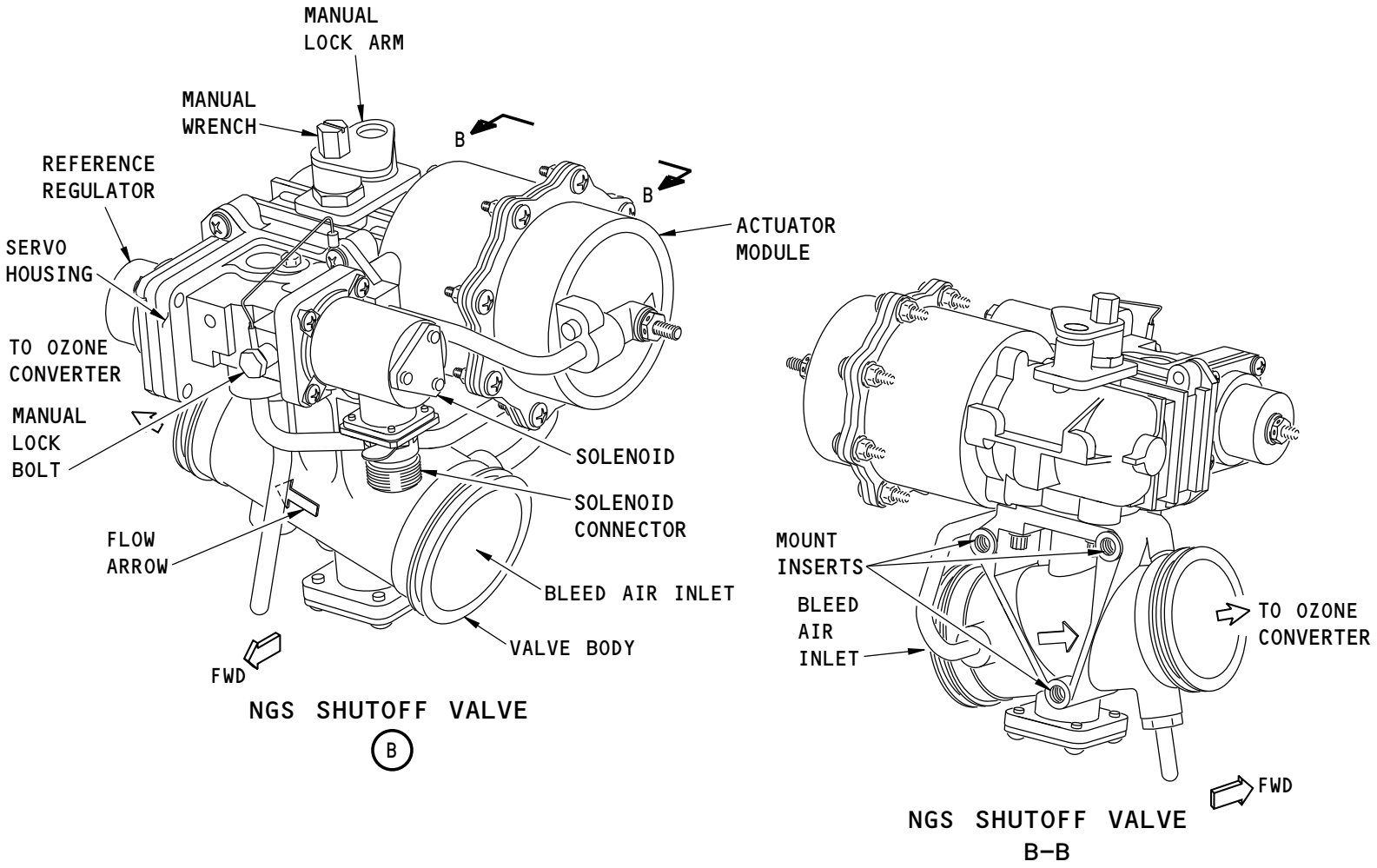
NITROGEN GENERATION SYSTEM SHUTOFF VALVE



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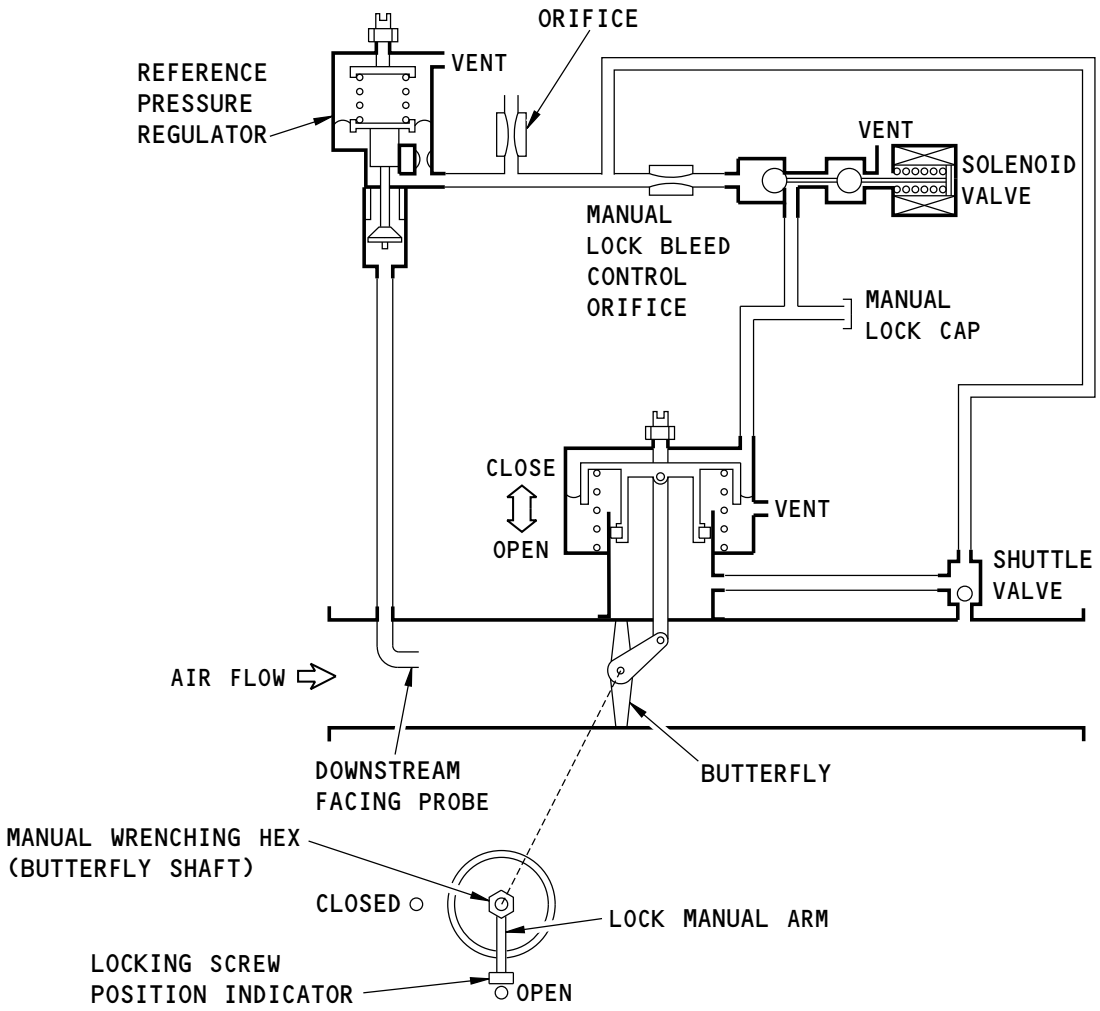
NITROGEN GENERATION SYSTEM SHUTOFF VALVE



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NITROGEN GENERATION SYSTEM SHUTOFF VALVE - FUNCTIONAL DESCRIPTION

OZONE CONVERTER

Purpose

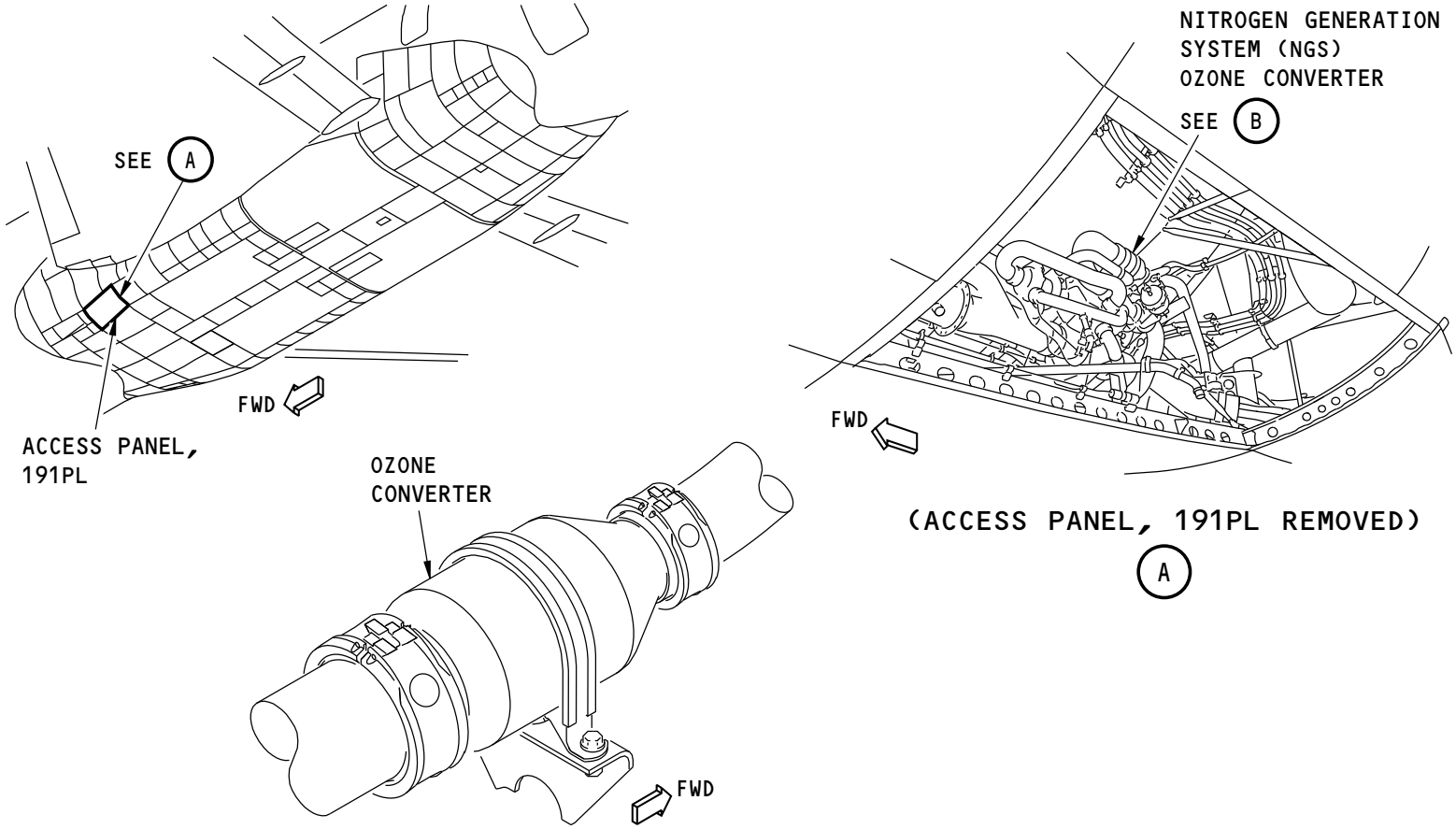
The ozone converter reduces the ozone content in the bleed air by catalytic conversion to oxygen. The oxygen converter will decrease the damage to the air separation module (ASM) fibers due to oxidation.

Location

The ozone converter is located on the outboard and aft side of the thermal control unit (TCU), and is accessible through the forward wing to body fairing panel, 191PL.

General Description

The ozone converter uses a nickel alloy substrate brazed into a Type 409 stainless steel mantle. The core is a straight-channel fin configuration to minimize pressure drop. The core is coated with a catalyst formulation that supplies high ozone conversion performance. Performance is maintained throughout the life of the unit by a contamination resistant coating.



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OZONE CONVERTER

HEAT EXCHANGER

Purpose

The heat exchanger is used to decrease the temperature of the hot bleed air to 170 ±10°F (76.7 ±5.6°C). The heat exchanger keeps hot bleed air out of the air separation module (ASM) and center tank if the bleed system fails.

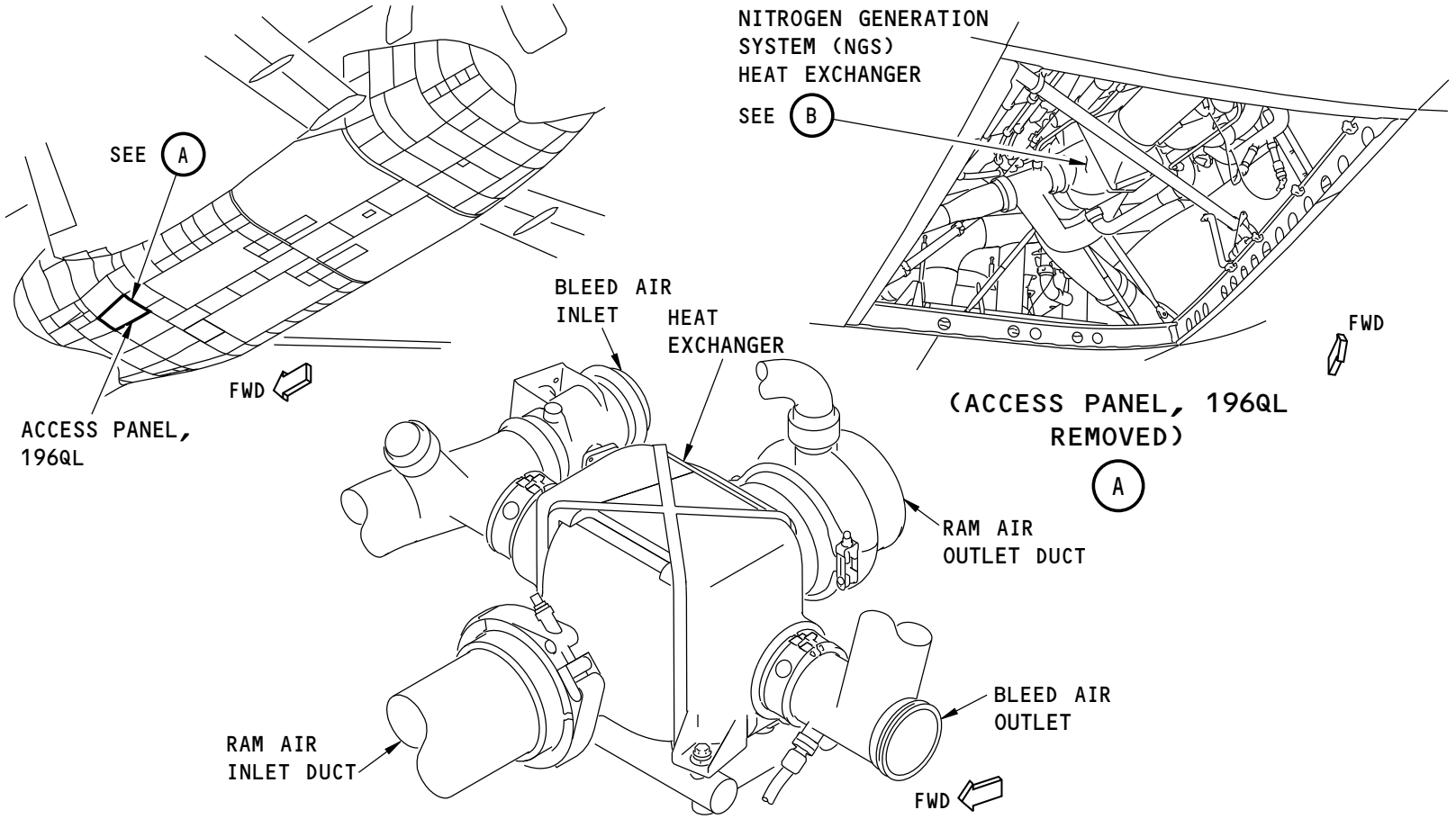
Location

The heat exchanger is located between the ram air inlet duct and the bleed air inlet duct in the Forward Wing to Body Fairing Panel, 191QL.

General Description

The heat exchanger is an aluminum, plate fin, single-pass, cross-flow, air-to-air unit. The core, a plate-fin heat transfer matrix, is brazed as an integral unit and welded to the heat exchanger manifolds and pans.

When engine bleed air moves through the heat exchanger, it is cooled down by a heat sink with the ambient air through the walls of the heat exchanger. Ambient air is supplied to the heat exchanger by either ram air or the fan. The ram air then flows overboard through an exit in the bottom of the access panel.



HEAT EXCHANGER

RAM AIR DOOR ACTUATOR

Purpose

The ram air door actuator (RADA) gives the necessary force to reposition the ram air door as necessary to meet the NGS cooling airflow needs.

Location

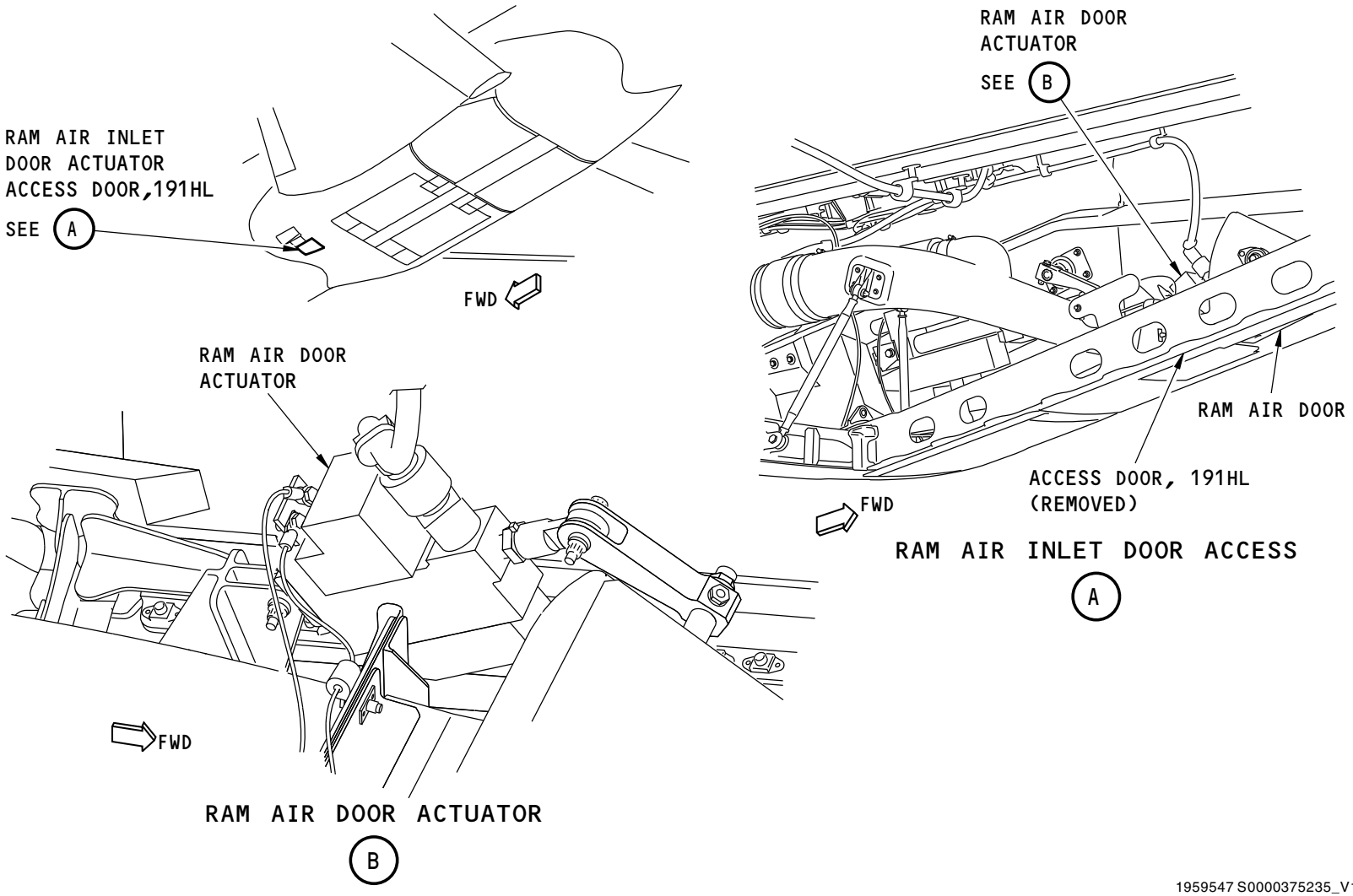
The RADA is forward of the thermal control unit (TCU), and aft of the ram air inlet door. To get access to the RADA, open the Forward Wing to Body Fairing Panel, 191HL.

General Description

The RADA is powered by a relay that supplies 115 VAC, 400Hz power to the motor, which turns the reduction gearbox and strokes the linear drive element. The relay is operated by the NGS controller torque motor driver controller, based on aircraft and system operating mode logic. The RADA includes a feedback position switch to signal to the NGS controller that the ram air door has moved towards the commanded position.

The RADA incorporates integral end-of-travel limit switches to precisely position the ram air door.

The RADA is equipped with spherical bearing rod ends that can be adjusted during the ram air door installation process.



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RAM AIR DOOR ACTUATOR

FILTER

Purpose

The air filter removes solid and aerosol particles from the bleed air.The filter prevents contamination of the air separation module (ASM).

Location

The air filter is inboard and aft of the ASU, found above the ECS Low Pressure Connection Door, 196CR.

General Description

The NGS air filter assembly is of a two stage design. There is an inner pleated coalescer filter pack and downstream, an outer high efficiency pleated filter pack.

The coalescer stage is manufactured from layers of high efficiency glass fibre, polyester and stainless steel, all pleated together into a filter pack. This layer gives the particulate and fluidic separation requirements. This layer uses a repulsion coalescence mechanism coupled with a wicking action to provide high efficient coalescence.

The outer pleated filter pack has layers of very high efficiency glass fibre, polyester and stainless steel, all pleated together into a filter pack. This layer makes sure that the whole filter element gives high efficiency particulate and fluidic protection to the downstream system components.

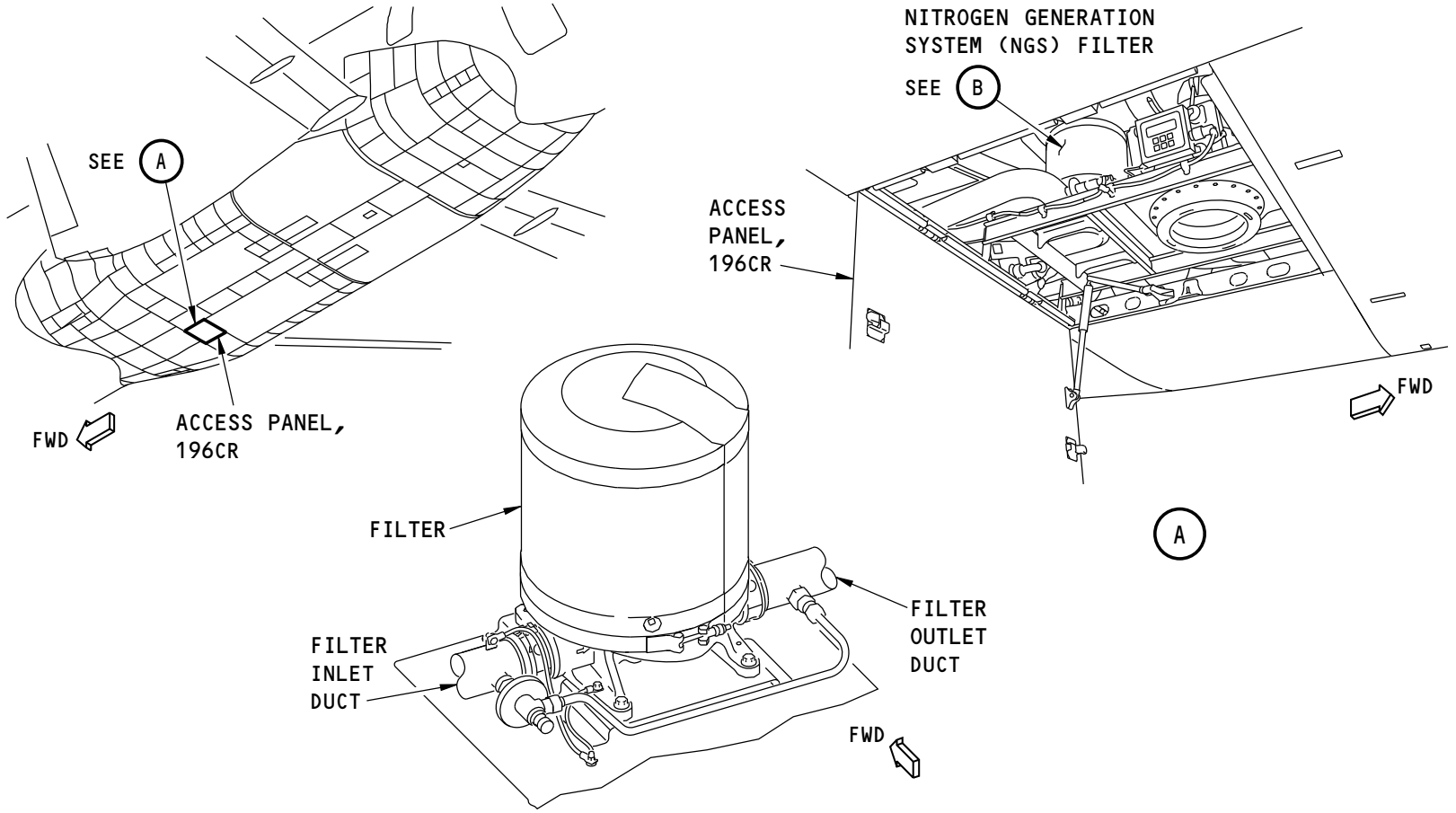
Separated fluidic contamination is then bled from the system through screened bleed orifices.

Both pleated filter packs are supported by perforated stainless steel and aluminium shrouds and found in aluminium end caps. The filter medias and support cores are potted into the end caps with an epoxy resin based compound.

The integrated element assembly, which uses the high efficiency filter and the coalescer, is found inside a filter housing which is split using a vee band closure to permit access for maintenance. The housing also supplies the inlet/outlet port interfaces, location for the bleed orifices and the aircraft installation features.

The filter assembly also includes an insulation jacket, which covers the bowl. This jacket is manufactured from polyimide foam and is lockwired to the main assembly with eyelets that are punched into the jacket.

A differential pressure switch is on the inlet duct to the filter. The differential pressure switch monitors the condition of the filter.



NITROGEN GENERATION SYSTEM (NGS) FILTER

B

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FILTER

RAM AIR CHECK VALVE

Purpose

The ram air check valve prevents a backflow of ram air when the fan operates.

Location

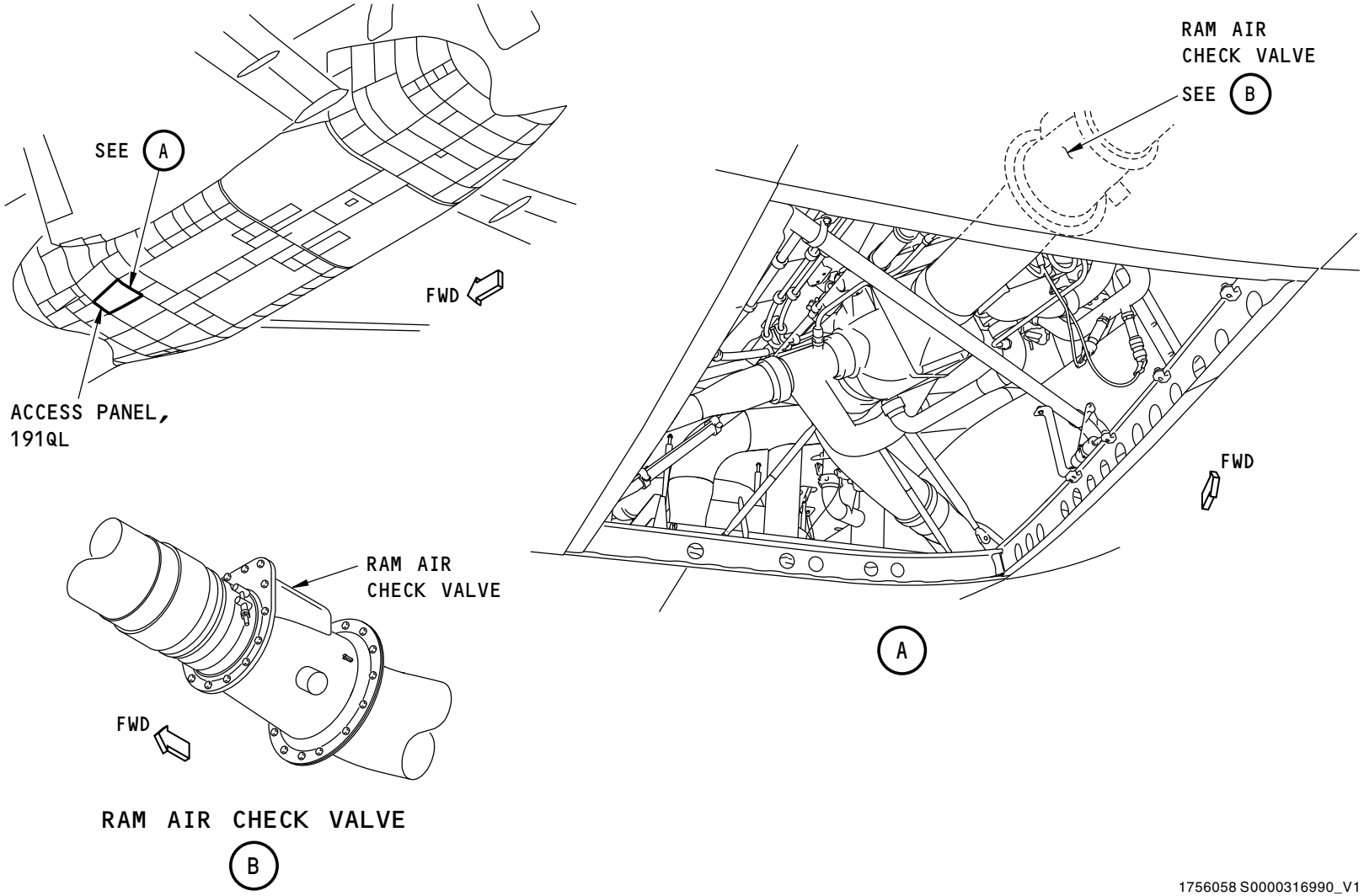
The ram air check valve is inboard of the fan and aft of the ram air door actuator (RADA) found in the Forward Wing to Body Fairing Panel, 191QL.

General Description

The check valve has a check valve body and a check valve flapper bolted in a check valve duct assembly, with a preformed packing installed in between. The check valve body and the check valve flapper have of a single circular flapper hinged about a hinge pin which is positioned perpendicular to the check valve body's vertical axis. A cotter pin installed through one end of the hinge pin retains the pin. The check valve flapper is loaded in one direction by washers and a helical compression spring. The inlet of the check valve body is machined to form a hose bead to mate with an aircraft pneumatic duct.

When airflow is in the direction shown by the airflow indicator plate, the check valve flapper is forced open, turning about the hinge pin until the check valve flapper contacts the stop. The check valve flapper will stay in this position as long as airflow continues in this direction.

When airflow reverses, the check valve flapper turns on the hinge pin to seat on the check valve body, thus preventing reverse airflow.



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RAM AIR CHECK VALVE

TEMPERATURE CONTROL VALVE

Purpose

The temperature control valve supplies temperature control by modulating the quantity of bleed air which bypasses the heat exchanger.

Location

The temperature control valve is inboard of the ozone converter and outboard of the turbo compressor shutoff valve found in the Forward Wing to Body Fairing Panel, 191QL.

General Description

The temperature control valve is an electrically controlled and pneumatically actuated modulating and shutoff valve. The butterfly plate assembly closure element is spring loaded closed. The temperature control valve uses an electro-magnetic control valve to modulate the position of the butterfly plate assembly to control the quantity of bleed airflow across a Nitrogen Generation System (NGS) heat exchanger.

Functional Description

Operation of Regulator Assembly

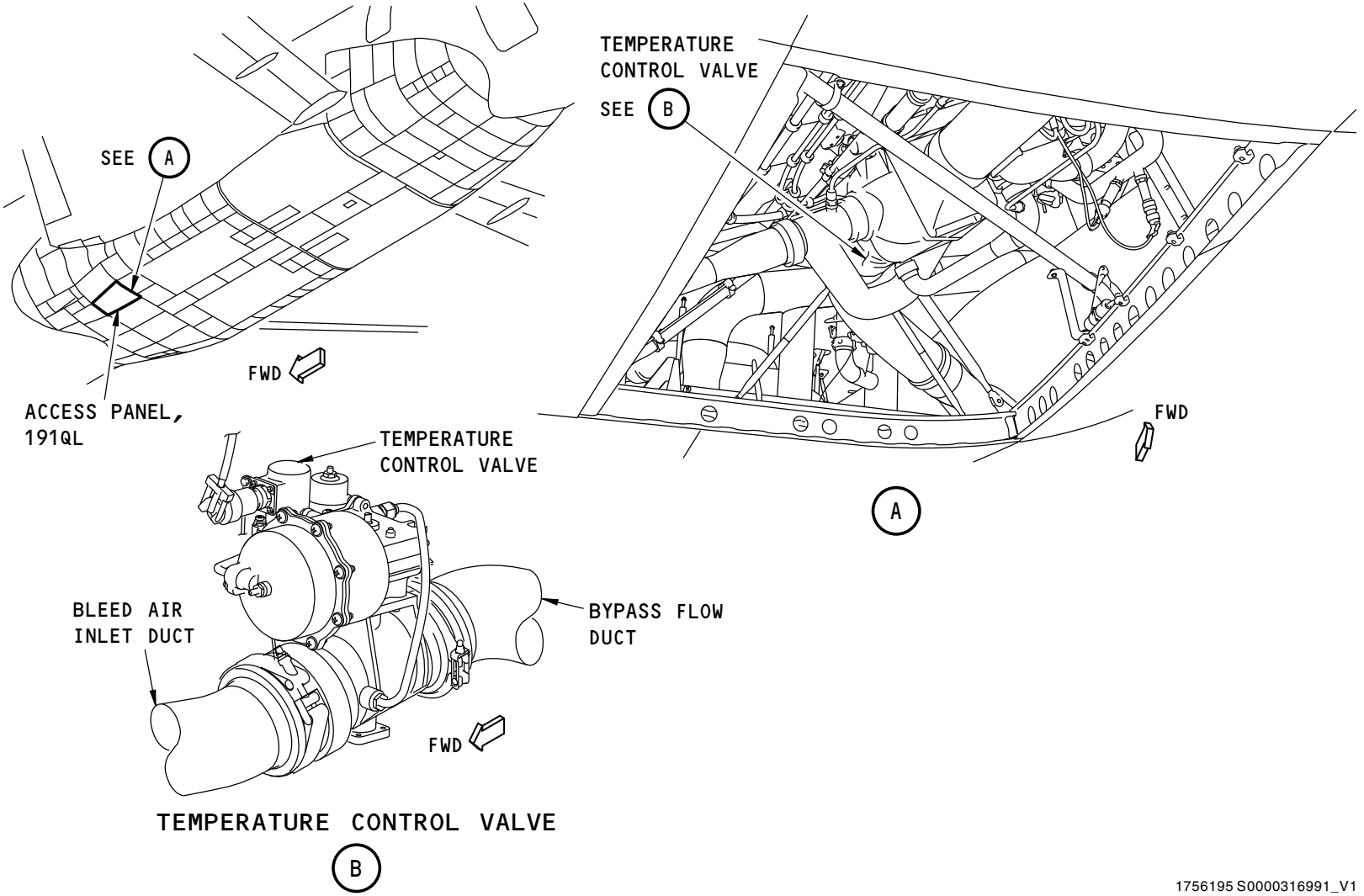
- The inlet pressure is let through a fluid pressure filter to the regulator assembly. Air flows past the poppet valve and poppet valve housing of the regulator assembly in the sensing chamber. When the pressure downstream of the regulator assembly has the necessary level, the force created by this pressure on the regulator diaphragm assembly acts opposite to the spring force and the poppet valve moves to the poppet valve housing seal until it gets force equilibrium. The regulator assembly produces a regulated output pressure independent of the supply pressure. The reference pressure then bypasses the honest orifice to the electro-magnetic control valve.

Operation with Electro-Magnetic Control Valve De-Energized

- With the electro-magnetic control valve de-energized (zero electrical current), the flapper blocks the supply nozzle and the opening chamber of the actuator assembly is vented to ambient through the electro-magnetic control valve as shown. The closing spring keeps the butterfly plate assembly in the closed position.

Operation with Electro-Magnetic Control Valve Energized

- As the electrical current to the electro-magnetic control valve increases, the flapper will move away from the supply nozzle to the vent, opposite that shown. The open supply nozzle will let regulator assembly pressure to the opening chamber of the actuator assembly.
- As the electro-magnetic control valve current changes, the butterfly plate assembly will be moved by the actuator assembly to an intermediate position to modulate the airflow. Thus airflow changes proportionally with the applied electro-magnetic control valve current.



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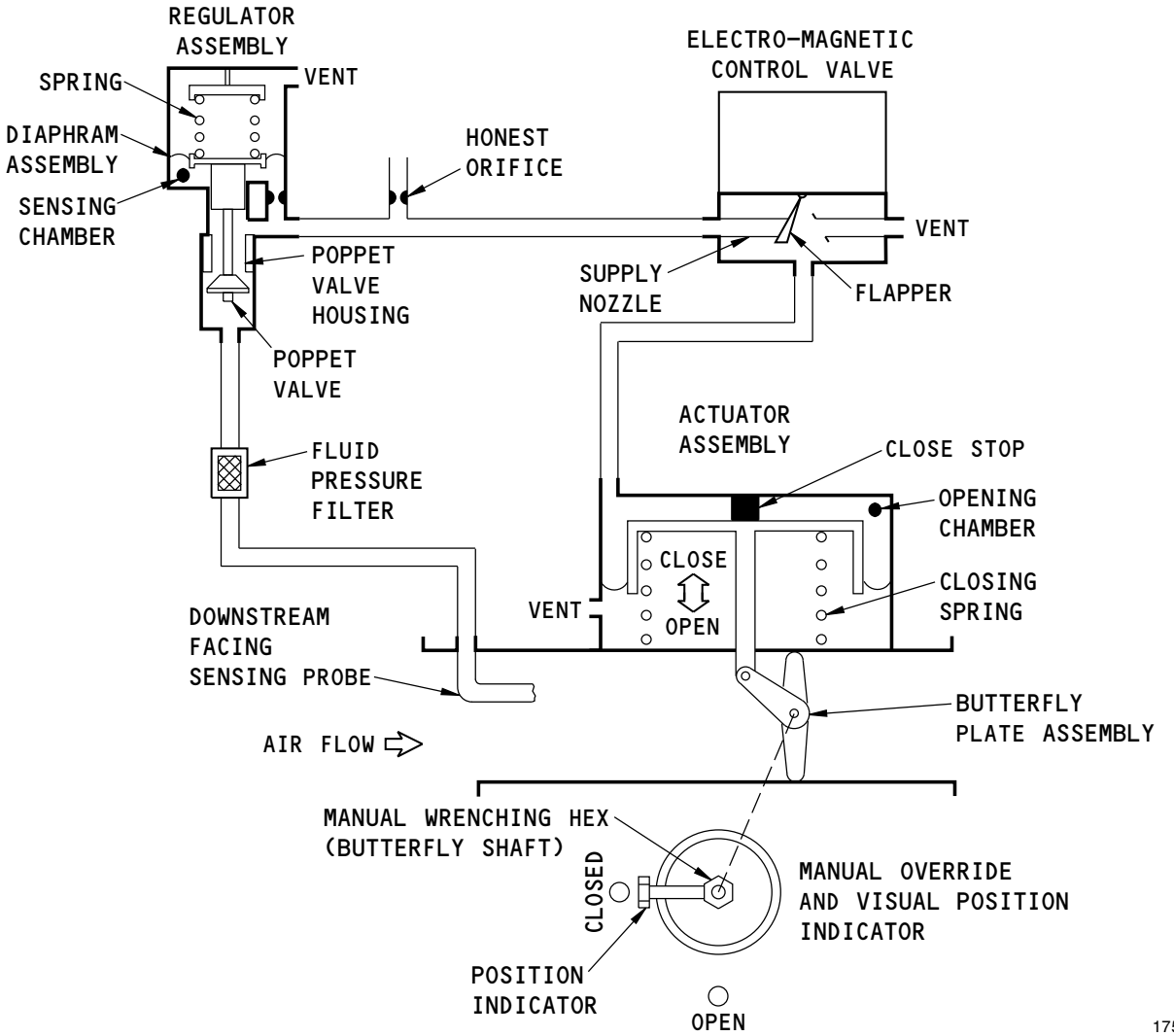
TEMPERATURE CONTROL VALVE



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TEMPERATURE CONTROL VALVE - FUNCTIONAL DESCRIPTION

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Purpose

The fan supplies cooling air to the heat exchanger while the aircraft is on the ground.

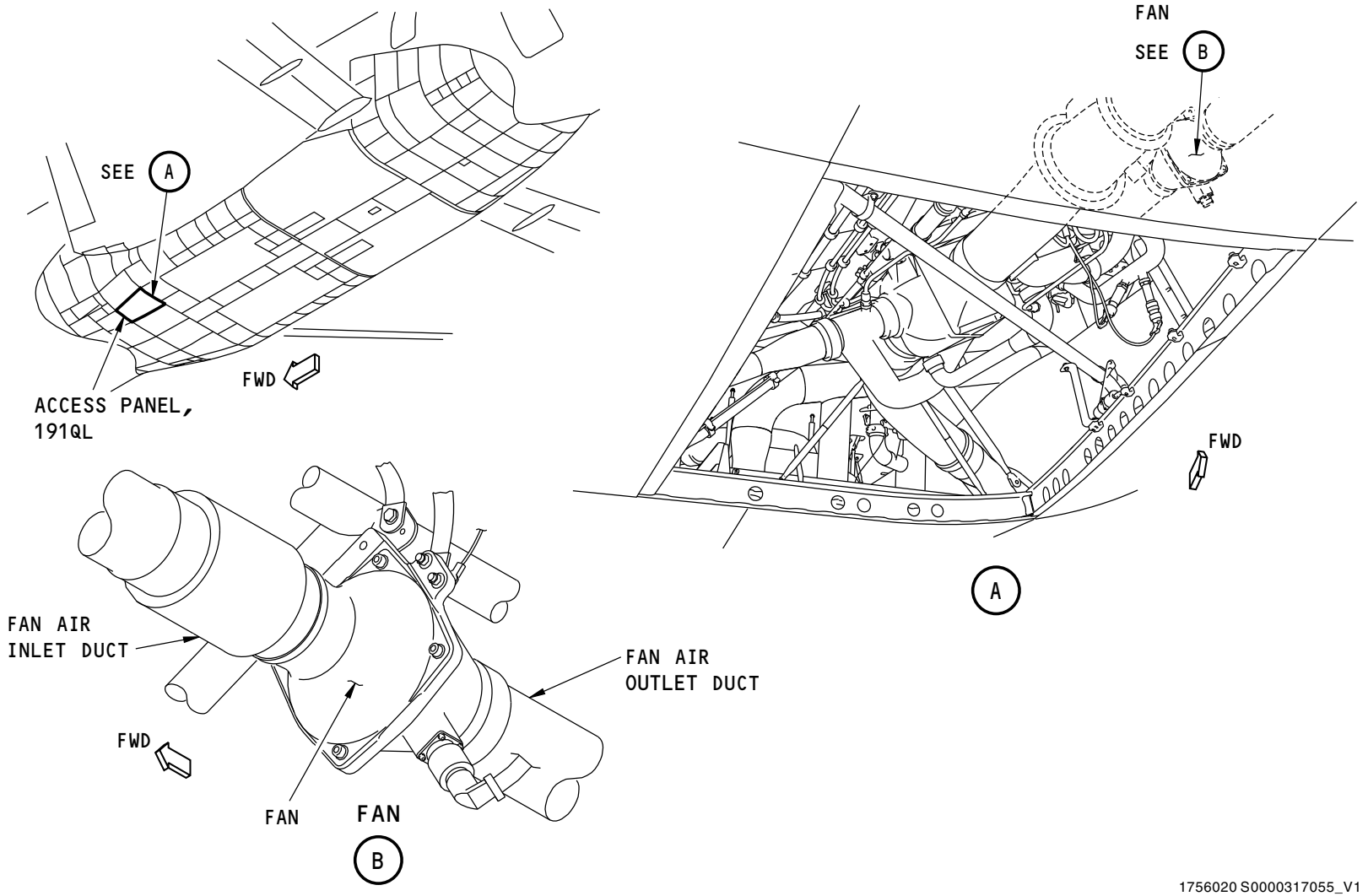
Location

The fan is found forward of the turbo compressor and outboard of the ram air check valve in the Forward Wing to Body Fairing Panel, 191QL.

General Description

The fan is a motor-driven, single stage design that supplies cooling air to the primary heat exchanger.

The fan runs when selected on by the controller, via a control signal to the fan contactor. Internal thermal protection switches will turn the fan off when an overtemperature condition exists.



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FAN

REGENERATIVE HEAT EXCHANGER

Purpose

The regenerative heat exchanger precools the bleed air that goes into the turbo compressor to keep the NGS bleed air temperature within design limits.

Location

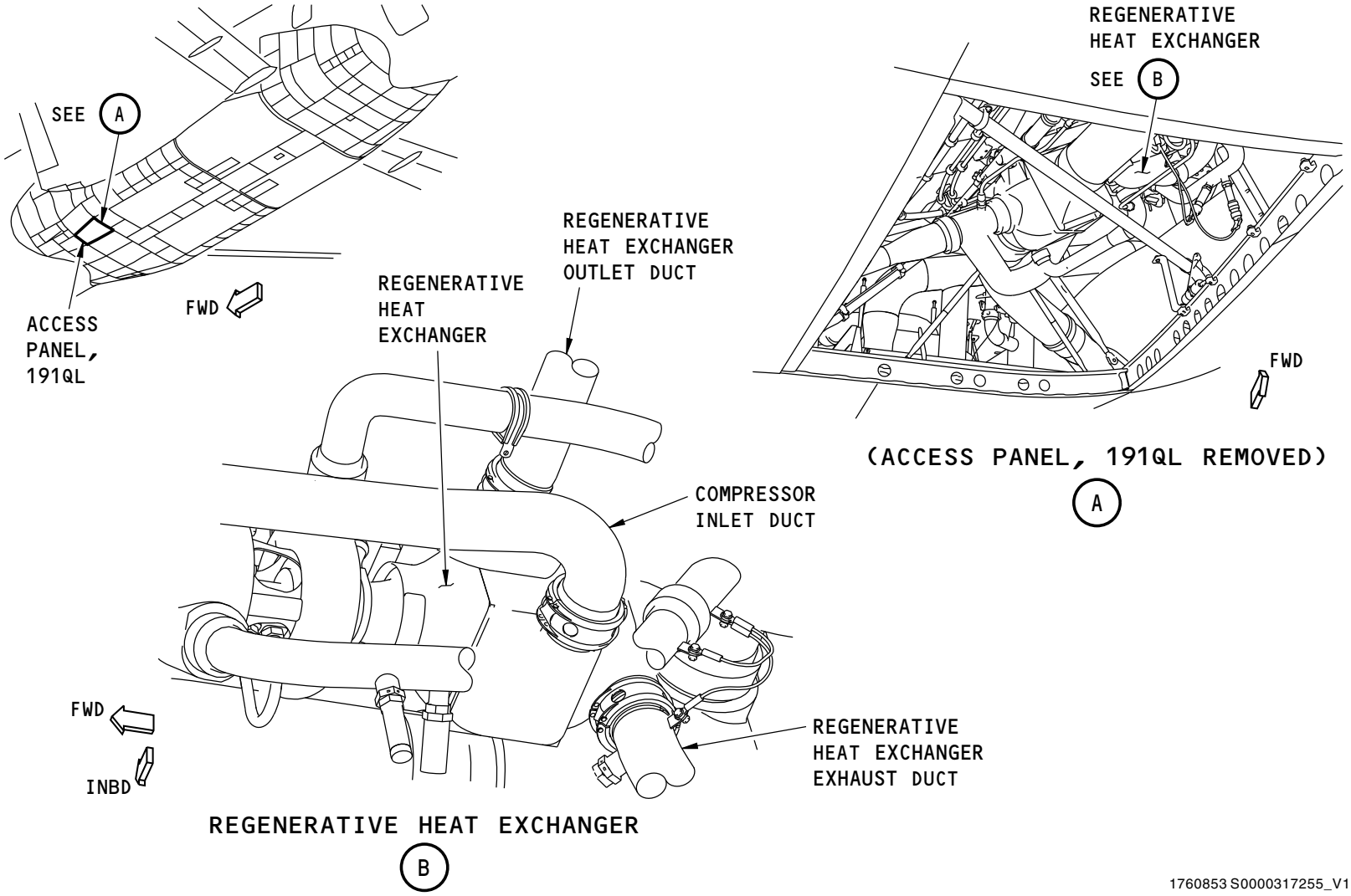
The regenerative heat exchanger is on the thermal control unit, between the turbo compressor and the primary heat exchanger, found in the Forward Wing to Body Fairing Panel, 191QL.

General Description

The regenerative heat exchanger design has a brazed aluminum core assembly, four cast aluminum pans, and three mounting feet.

Hot air from the engine bleed air system goes into the regenerative heat exchanger via the hot-circuit inlet, where it is cooled in the core by alternating passages of cool air before it goes into the compressor inlet.

The cold air circuit flow comes from the engine bleed air circuit, through the NGS turbo compressor turbine, where it is expanded, reducing both the temperature and pressure, before it goes into the regenerative heat exchanger.



1760853 S0000317255_V1

REGENERATIVE HEAT EXCHANGER

TURBO COMPRESSOR

Purpose

The turbo compressor compresses the bleed air to supply boosted air flow to the air separation unit (ASU).

Location

The turbo compressor is on the thermal control unit, forward of the regenerative heat exchanger and outboard of the ram air duct, in the Forward Wing to Body Fairing Panel, 191QL.

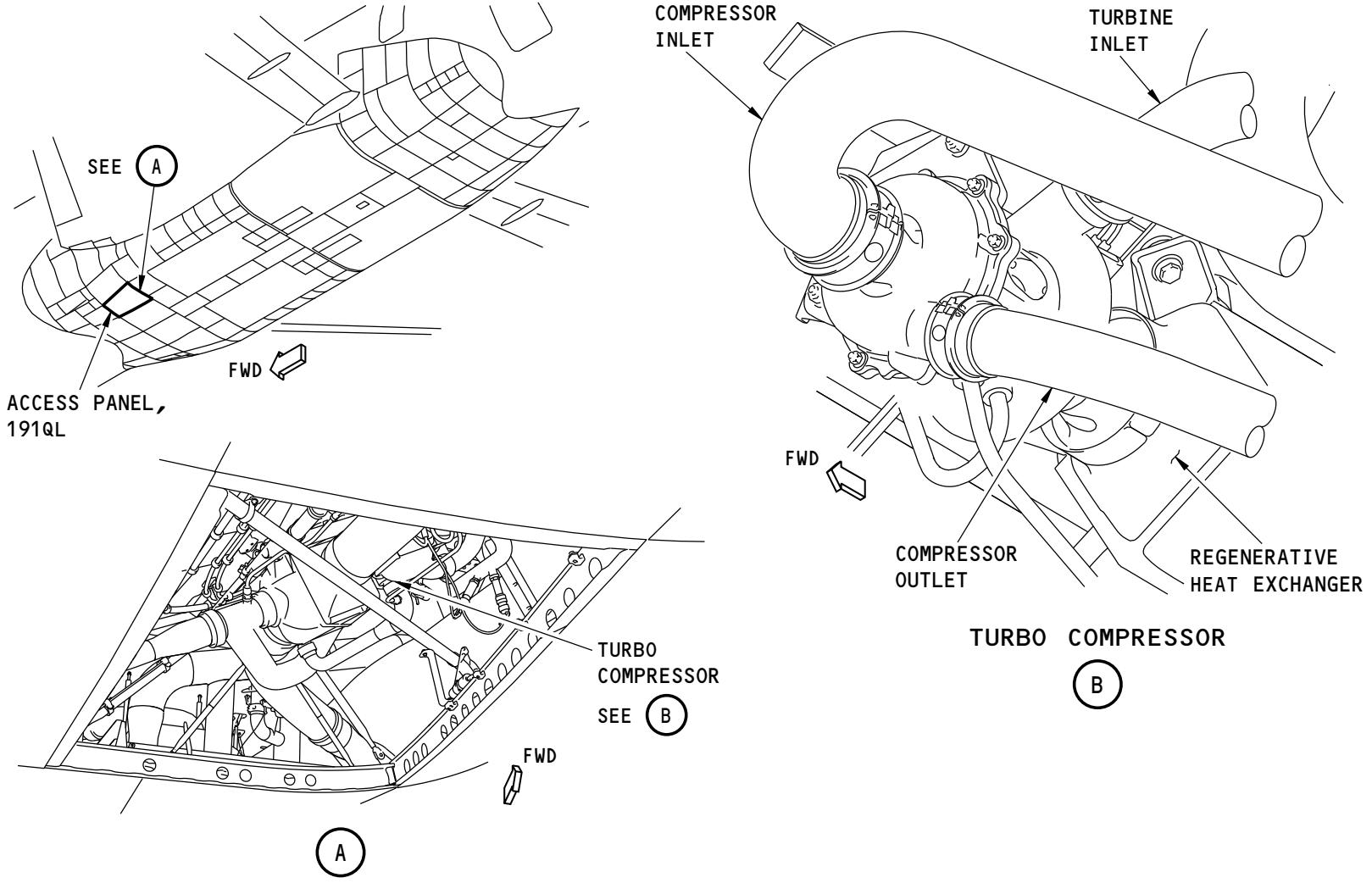
General Description

The turbocompressor has a two-wheel (turbine and compressor), single shaft rotating assembly supported by air bearings. The compressor is of the radial-outflow type with a diffuser, and the turbine is of the radial-inflow type.

When the NGS controller commands the turbo compressor shutoff valve open, engine bleed air is introduced to the turbine inlet port. The bleed air is drawn through the turbine by the lower absolute pressure at the turbine exit. The power produced by the turbine is used to drive the compressor. Air exiting the turbine is cooled due to expansion.

The cooled air turbine exit air is used by the regenerative heat exchanger to cool the bleed air that enters the compressor. Engine bleed air from the regenerative heat exchanger hot-side exit enters the compressor inlet, where it is compressed to a higher pressure and temperature. The compressor exit air goes through the main heat exchanger and heat exchanger bypass, and on to the ASU.

Cooling air to the turbo compressor bearing cavity is supplied from the bleed air exit side of the ram heat exchanger.



1796966 S0000317261_V1

TURBO COMPRESSOR

BLEED AIR CHECK VALVE

Purpose

The bleed air check valve prevents back flow from the turbo compressor side of the valve into the ozone converter when the turbo compressor is operating.

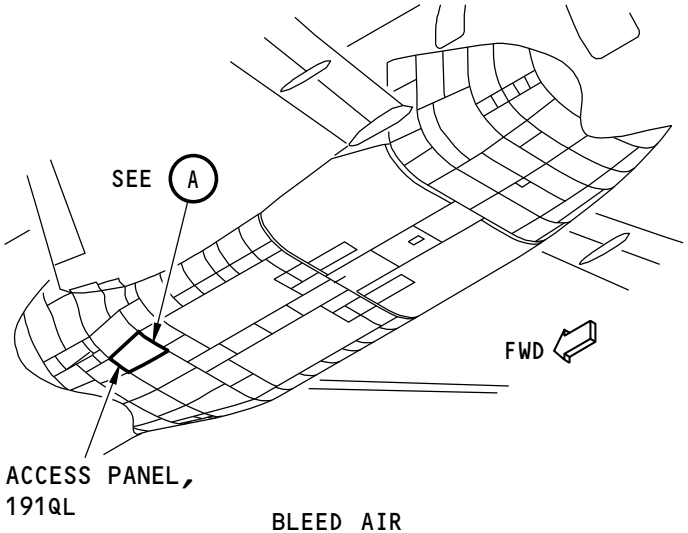
Location

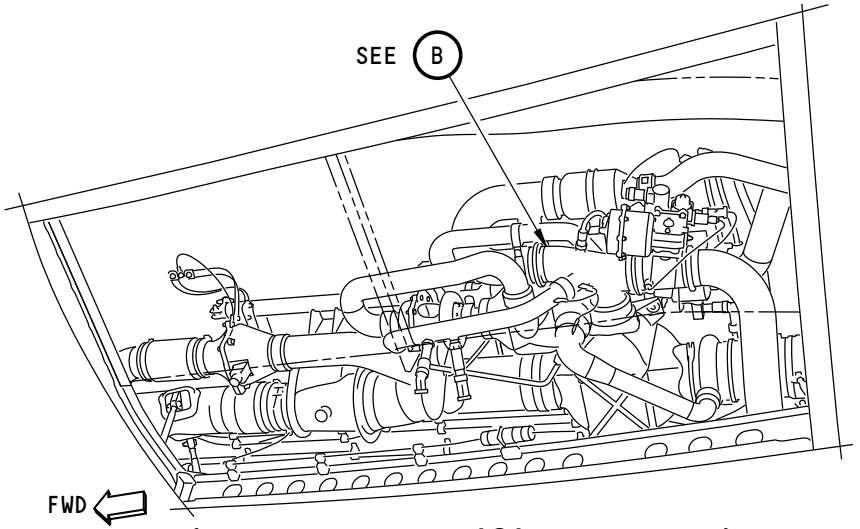
The bleed air check valve is on the thermal control unit, outboard of the regenerative heat exchanger and forward of the temperature control valve, in the Forward Wing to Body Fairing Panel, 191QL.

General Description

The NGS bleed air check valve is a 3 in. (76 mm) diameter insert type check valve, which is installed between two duct flanges and retained by a clamp. A clocking pin orients the valve in the system and prevents incorrect installation. The bleed air check valve uses two semi-circular flappers that are hinged by a pin perpendicular to the airflow.

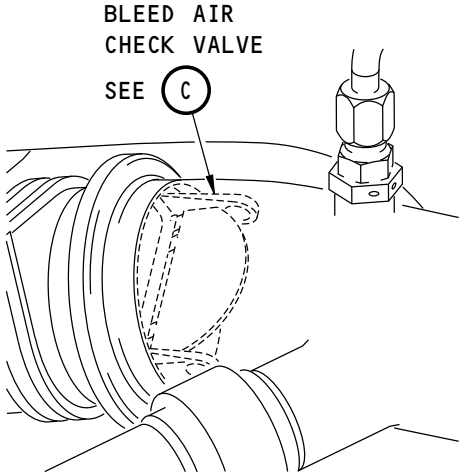
When the bleed air check valve is in the open position, bleed air passes through the check valve before it goes into the main heat exchanger and heat exchanger bypass.



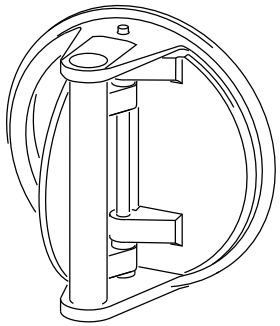


(ACCESS PANEL, 191QL REMOVED)
(RAM AIR DUCT NOT SHOWN)

A



B



BLEED AIR CHECK VALVE

C

1797307 S0000317306_V1

BLEED AIR CHECK VALVE

TURBO COMPRESSOR SHUTOFF VALVE

Purpose

The turbo compressor shutoff valve gives backup protection for the turbo compressor if the controller fails. This is controlled by the turbo compressor thermal switch.

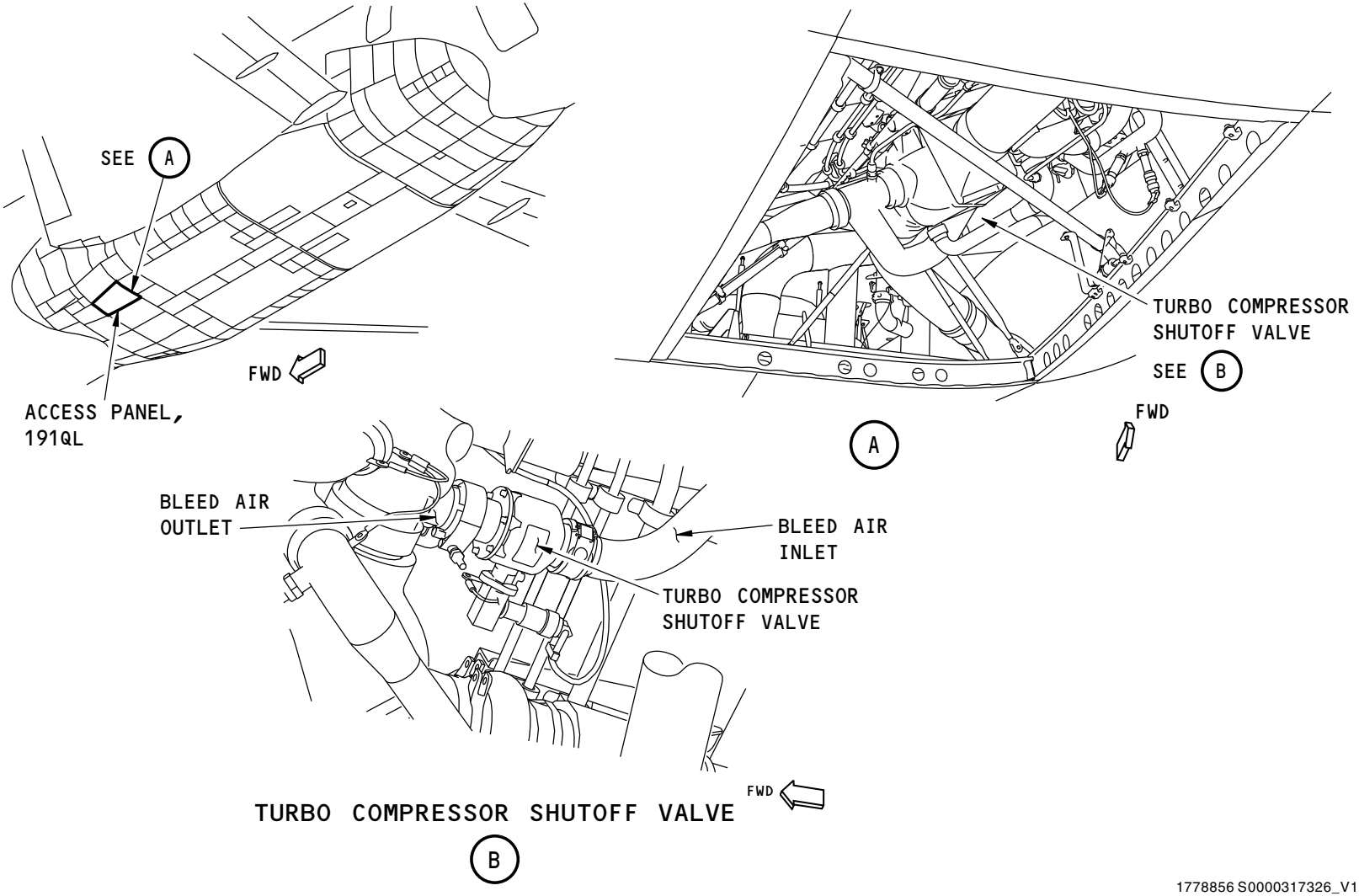
Location

The turbo compressor shutoff valve is on the thermal control unit, between the temperature control valve and the heat exchanger, located in the Forward Wing to Body Fairing Panel, 191QL.

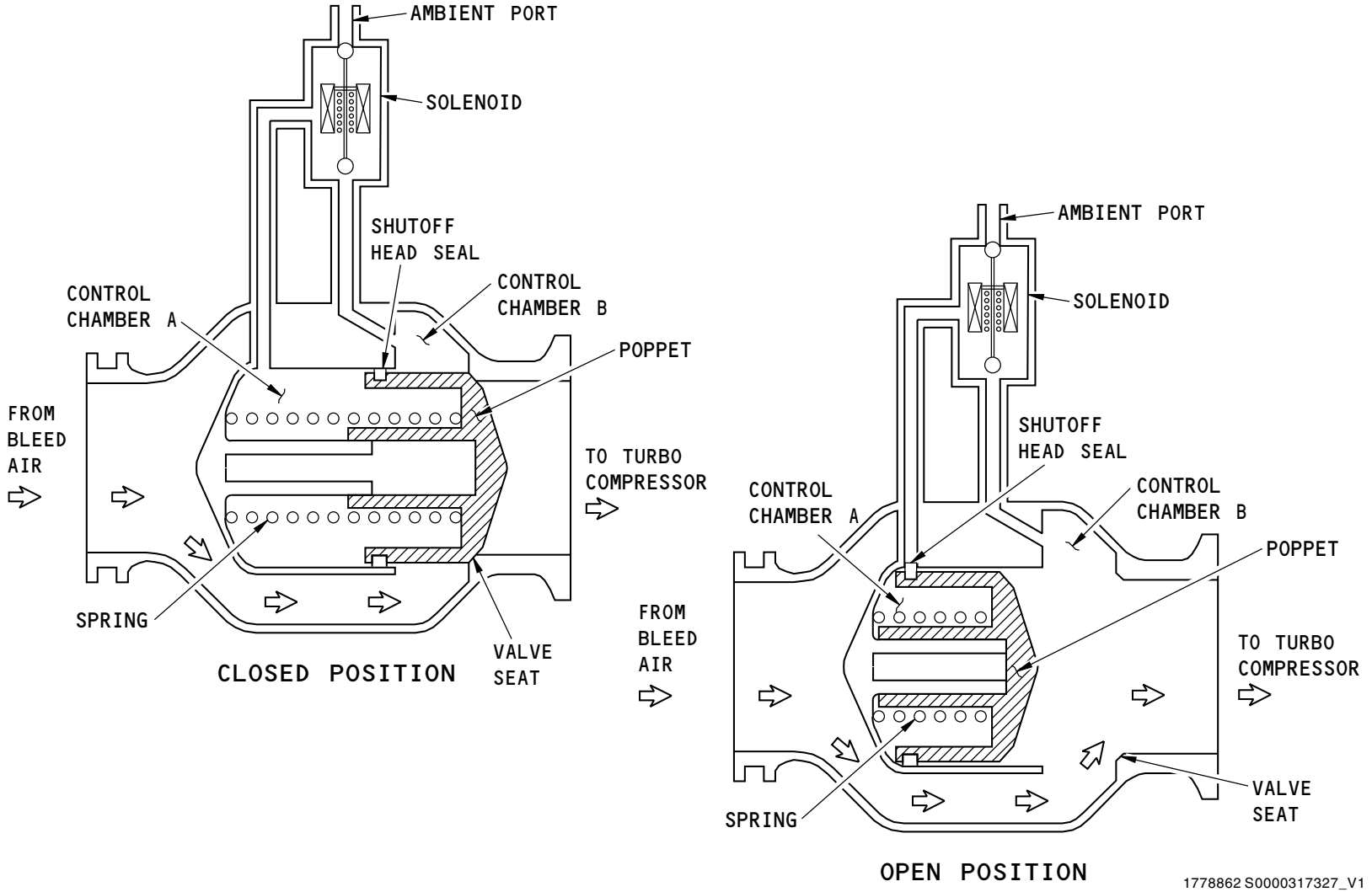
General Description

The TCSOV is a normally closed in-line poppet valve. It works utilizing the differential pressure between ambient and the inline fluid. With the solenoid deenergized, the supply pressure at the valve inlet is fed to the valve control chamber via the solenoid. The solenoid ambient port is closed in this condition, thereby ensuring that the control chamber pressure does not decay. No inward force exists across the differential area in this case. The valve shutoff head is held against its seat (closed) by a combination of the pressure in the control chamber and the spring. In the event of electrical failure and/or zero supply pressure, the valve is held in the normally closed position by the spring.

When the solenoid is energized, it moves in the opposite direction, thus preventing the supply pressure at the valve inlet from entering the valve control chamber. The solenoid ambient port is now open, and the pressure in the control chamber is allowed to decay to ambient. There is a differential area between the valve seat and the valve shutoff head seal. The supply pressure acts on this differential area; the force generated overcomes the spring force, and the valve starts to open. When the valve is partially open, the pressure acts on the full area, snapping it to the full-open position.



TURBO COMPRESSOR SHUTOFF VALVE



TURBO COMPRESSOR SHUTOFF VALVE - FUNCTIONAL DESCRIPTION

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FILTER DIFFERENTIAL PRESSURE SENSOR

Purpose

The filter differential pressure switch indicates when the filter needs to be cleaned or replaced.

Location

The filter differential pressure switch is found aft of the filter in the ECS Low Pressure Connection Door, 196CR.

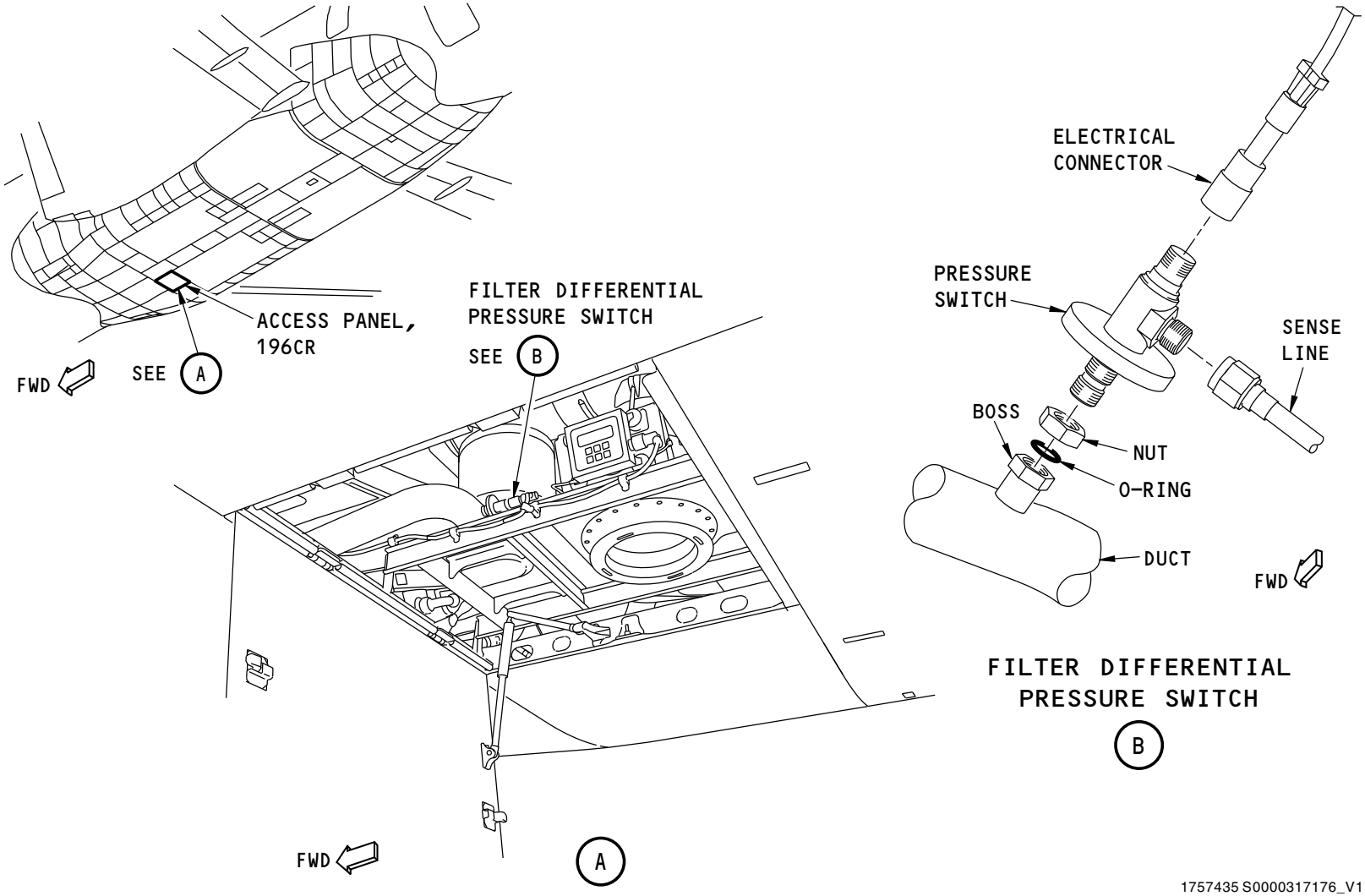
General Description

The pressure switch is a snap action, diaphragm type switch with an electrical connector. This is attached directly to the air filter's inlet air duct. A sense line from the outlet side of the air filter is also connected to the pressure switch.

The pressure switch closes when there is a pressure drop of 1.2 psid (8.3 kPa) across the filter. This sends a signal to the controller that you must clean or replace the filter. The controller sends a signal to the BITE display unit.

When the pressure difference decreases to 0.3 psid (2.1 kPa), the pressure switch opens, and the indication does not show.

The pressure switch is for indication. There are no nuisance trips.



FILTER DIFFERENTIAL PRESSURE SWITCH

THERMAL CONTROL UNIT - THERMAL SWITCH

Purpose

The thermal switch works in conjunction with the turbo compressor shutoff valve to make sure that the maximum system bleed temperature stays under 500°F (260°C).

Location

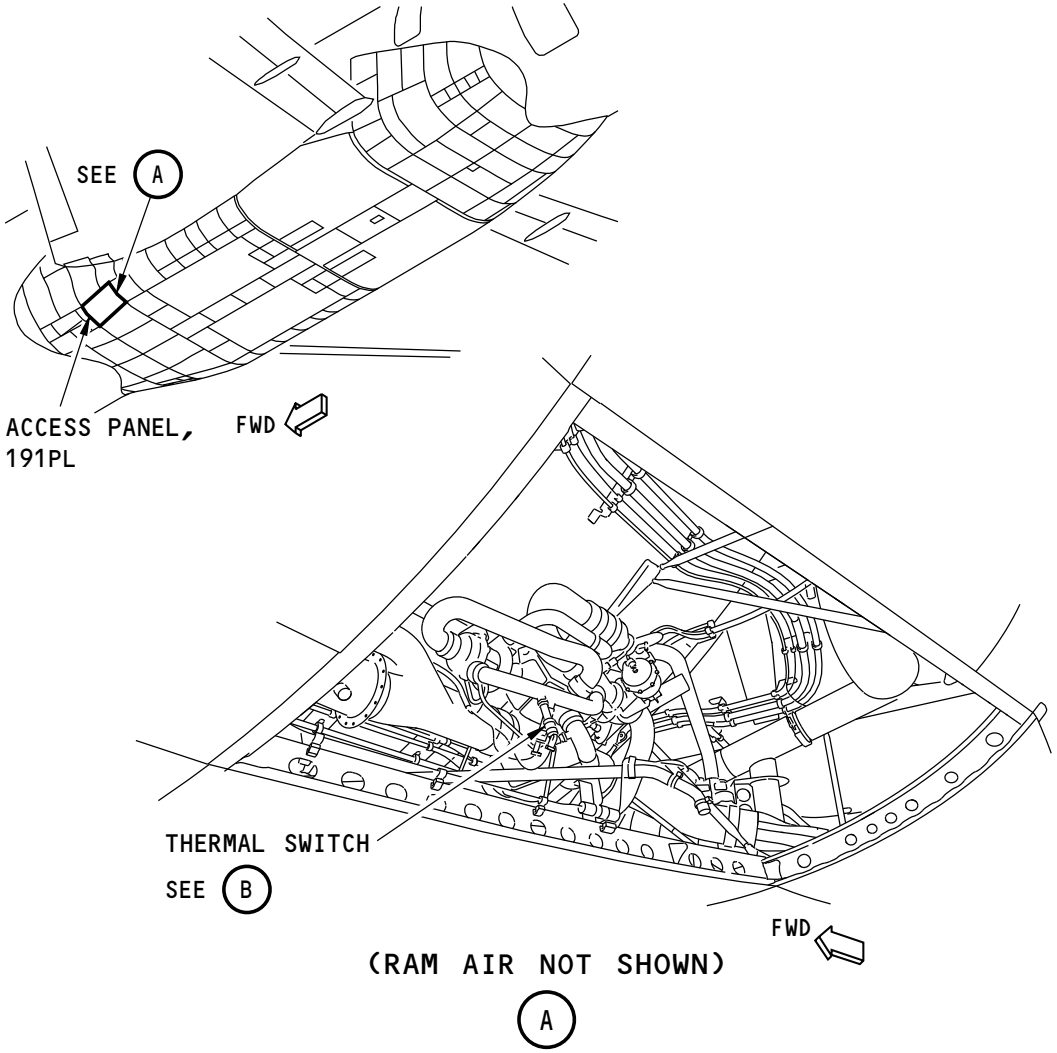
The thermal switch is on the outlet duct of the turbo compressor, in the Forward Wing to Body Fairing Panel, 191PL.

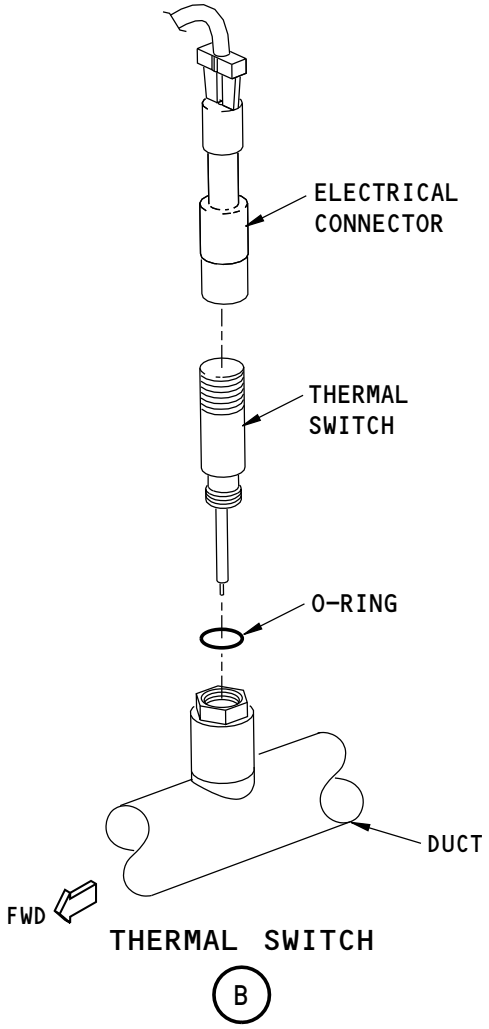
General Description

The thermal switch is electrically connected to the turbo compressor shutoff valve (TCSOV), and will cause the TCSOV to close upon switch actuation.

The thermal switch usually stays in the closed position and moves to the open position when the sensing temperature reaches above its temperature setpoint of 475 ±10°F (246 ±6°C). Upon actuation, the switch will reset when the temperature drops below 450°F (232°C).

The thermal switch contacts are put in series to the excitation coil of the TCSOV and its sensing part is pput within the duct immediately downstream of the compressor outlet port from the turbo compressor.





1757432 S0000317397_V1

THERMAL CONTROL UNIT - THERMAL SWITCH

THERMAL CONTROL UNIT - TEMPERATURE SENSOR

Purpose

The temperature sensor measures the temperature of the bleed air exiting the turbo compressor for the purpose of system fault detection.

Location

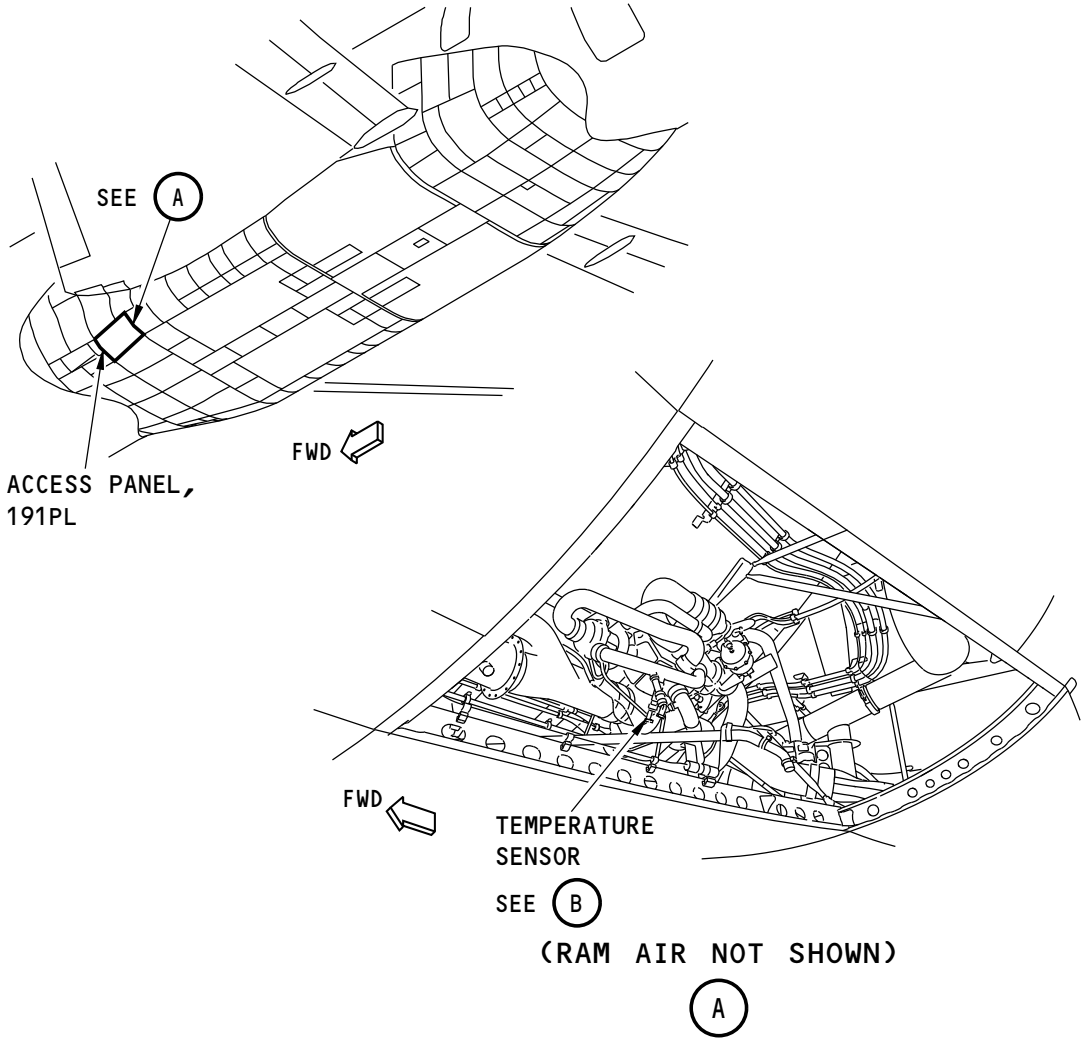
The temperature sensor is on the outlet duct of the turbo compressor, located in the Forward Wing to Body Fairing Panel, 191PL.

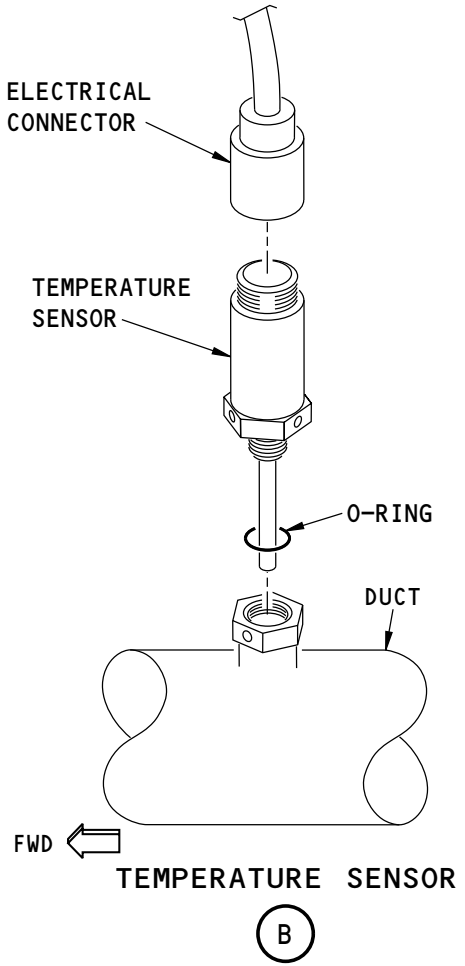
General Description

The temperature sensor is a dual element probe type unit with an electrical connector. It is sealed in a corrosion-resistant stainless steel probe.

The temperature sensor monitors the air temperature going out of the turbo compressor. It sends temperature data to the NGS controller.

When the temperature measured by the temperature sensor exceeds 465°F (241°C), the NGS controller removes power to the turbo compressor shutoff valve. The turbo compressor shutoff valve closes and deactivates the turbo compressor.





1757742 S0000317406_V1

THERMAL CONTROL UNIT - TEMPERATURE SENSOR

THERMAL CONTROL UNIT - PRESSURE SENSOR

Purpose

The pressure sensor monitors the bleed air inlet pressure and sends the signal to the NGS controller.

Location

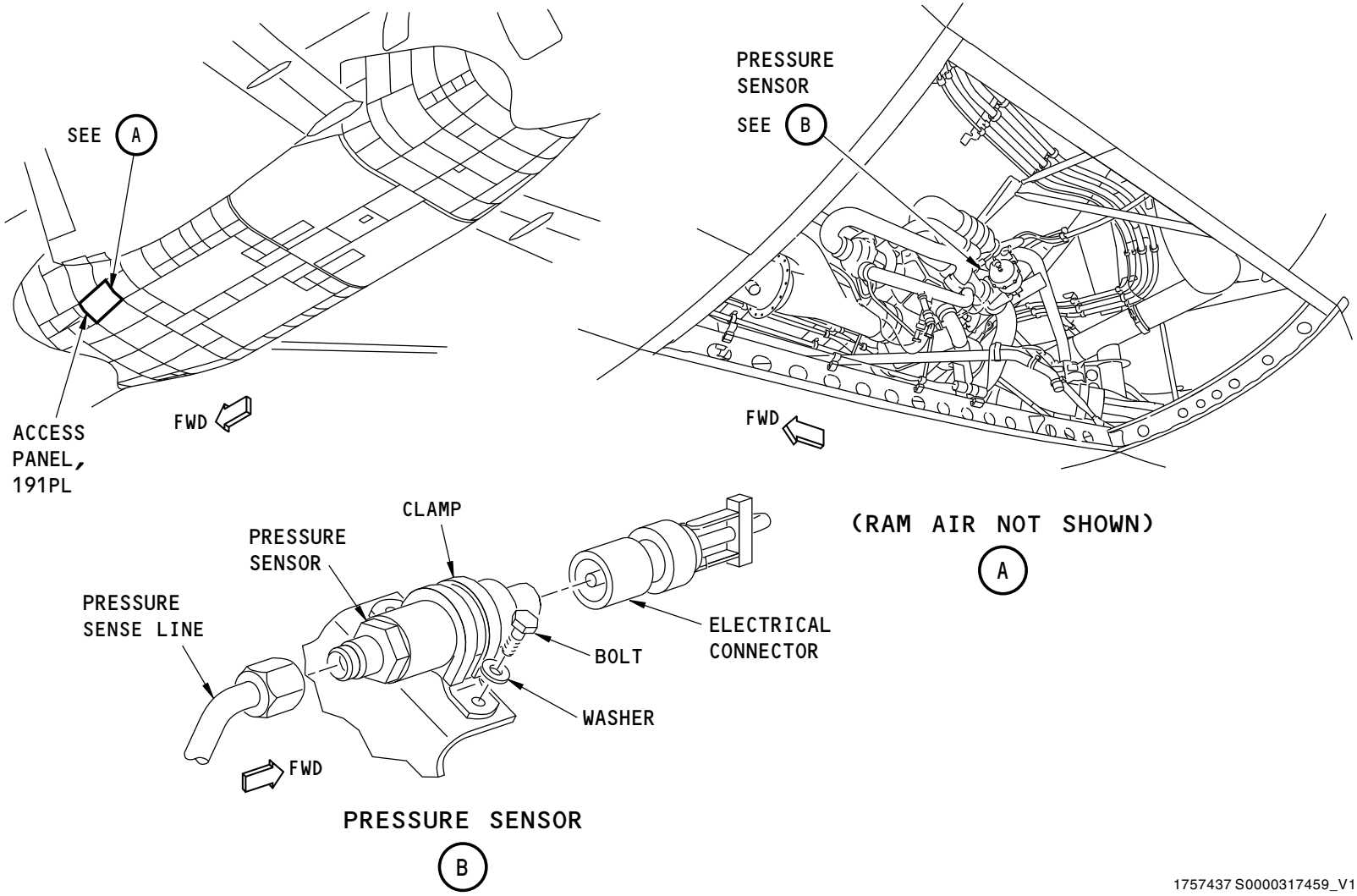
The pressure sensor is installed on the thermal control unit, inboard and aft of the ozone converter, found in the Forward Wing to Body Fairing Panel, 191PL.

General Description

The pressure sensor has a hermetically sealed electronic circuitry housed in a corrosion-resistant steel shell. The pressure sensor has pressure sensing elements. An external voltage is supplied and the output current is proportional to changes in air pressure. The housing is boss-mounted with fitting end threads. A six-pin connector facilitates electrical connection.

Pressure is delivered to the sensor through a sense line connected to the turbo compressor outlet duct. The electrical connector on the sensor is connected to the NGS controller via aircraft electrical wiring. The NGS controller supplies power to the sensor which then monitors the bleed air pressure.

Pressure information is used by the NGS controller for system BIT, fault monitoring, and overpressure shutdown control.



1757437 S0000317459_V1

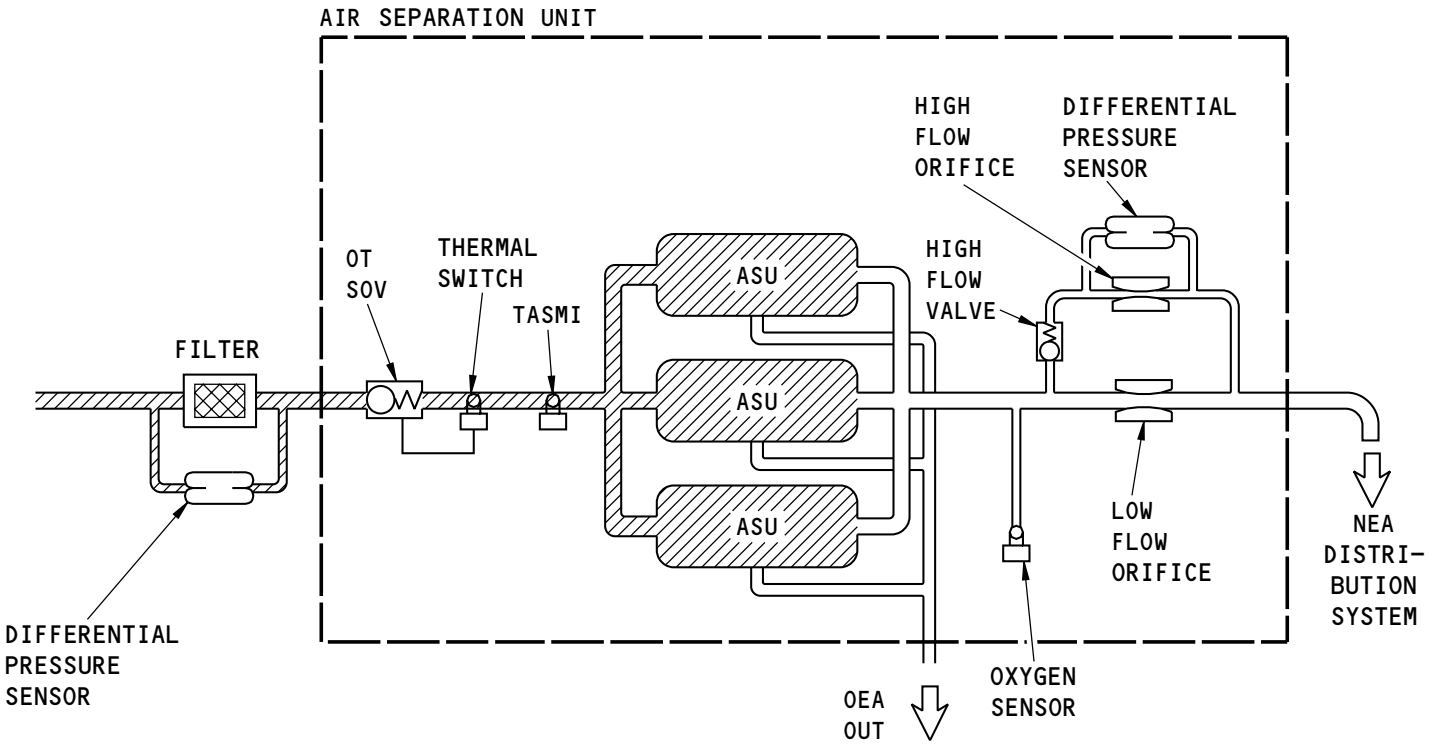
THERMAL CONTROL UNIT - PRESSURE SENSOR

AIR SEPARATION UNIT - INTRODUCTION

General

The Nitrogen Generation System (NGS) uses hot bleed air to make Nitrogen Enriched Air (NEA) for the center tank. The Air Separation Unit (ASU) separates oxygen and nitrogen molecules within the bleed air as it passes through. The Oxygen Enriched Air (OEA) is discharged and ducted overboard, while the NEA is delivered to the center wing tank. These are the components of the ASU:

- Air Separation Module
- High Flow Valve
- Overtemperature Shutoff Valve
- Air Separation Unit - Differential Pressure Sensor
- Air Separation Unit - Oxygen Sensor
- Air Separation Unit - Thermal Switch
- Air Separation Unit - Temperature Sensor



1779294 S0000317675_V1

AIR SEPARATION UNIT

AIR SEPARATION MODULE

Purpose

The air separation modules (ASM) process conditioned, filtered engine bleed air to generate nitrogen enriched air (NEA) for fuel tank inerting.

Location

The ASMs are located in the Forward Wing to Body Fairing Panel, 192QR.

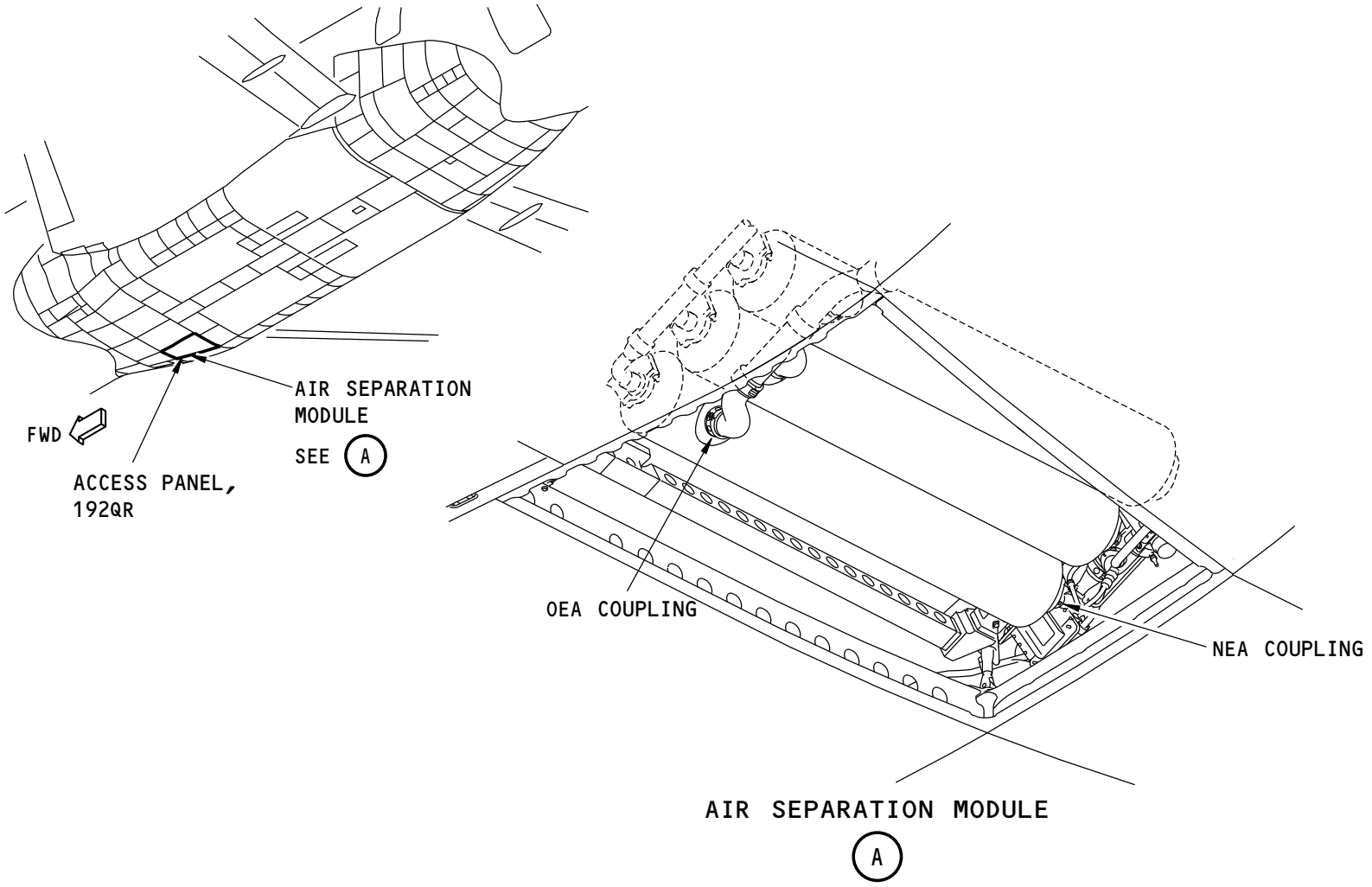
General Description

The ASM is a permeable fiber membrane bundle in an aluminum housing.

The three ASM units are ducted in parallel with each other. These three ASM units are installed on the ASU frame assembly, and are connected to each other with the bleed air, NEA and oxygen enriched air (OEA) ducting.

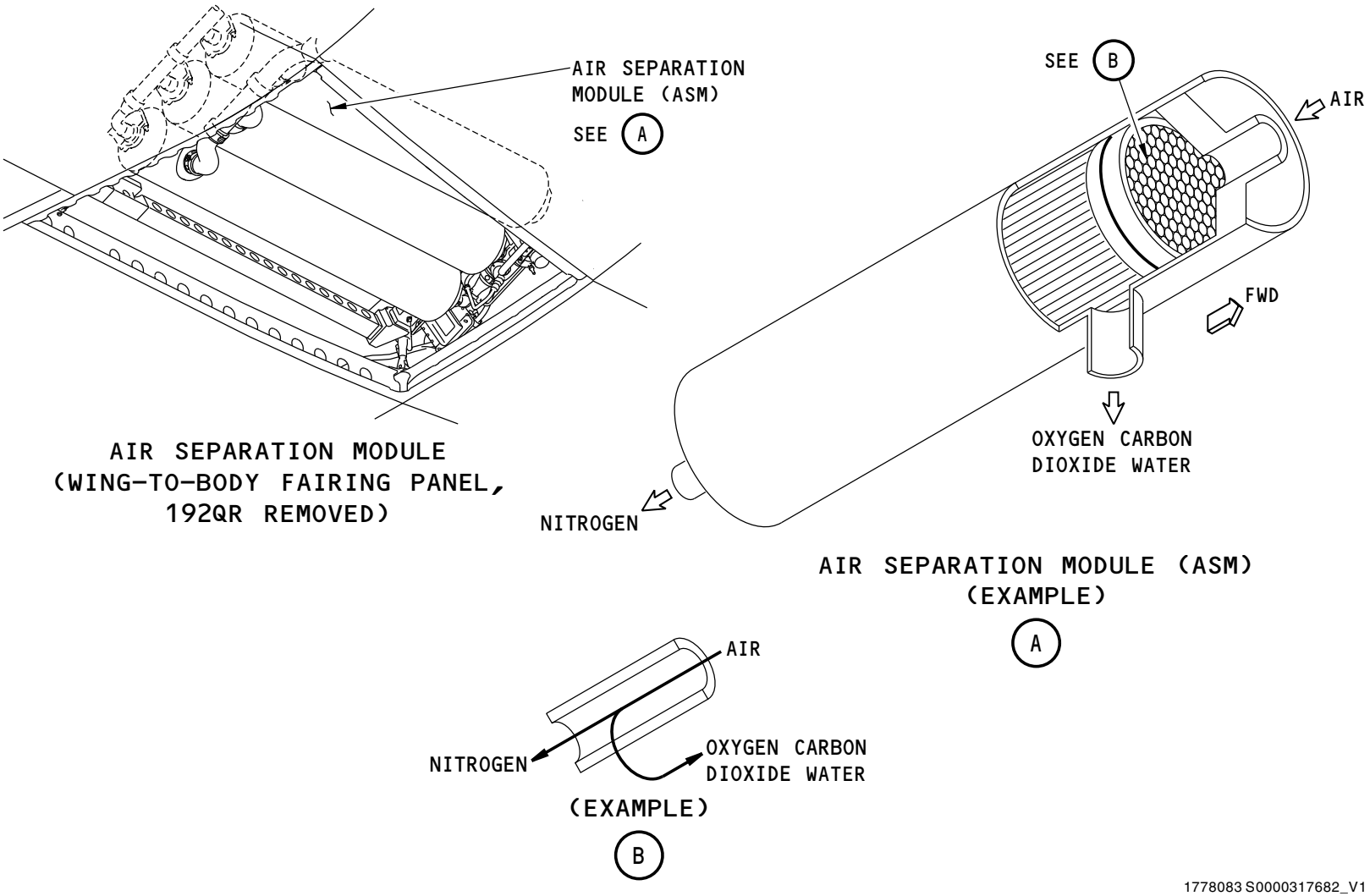
The inlet and outlet fittings are flexible couplings that interconnect to bleed air supply and NEA outlet ducts. The inlet, OEA, and NEA port are also flexible coupling style fittings.

Bleed air enters the fiber bundle through the inlet manifold. As bleed air passes through the fiber bundle, oxygen is separated through the fiber walls. The waste gas that is rich in oxygen exits the fiber bundle through the OEA port. The NEA flow exits through the outlet port.



1778075 S0000317681_V1

AIR SEPARATION MODULE



1778083 S0000317682_V1

AIR SEPARATION MODULE - FUNCTIONAL DESCRIPTION

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HIGH FLOW VALVE

Purpose

The high-flow valve is used to select high-flow operation upon command from the NGS controller. During normal operation, high flow is used during descent, and also during maintenance operation or during ground operations after a system restart. When the high-flow valve is open, a parallel flow path to the fuel tank is activated, which lets there be increased NEA flow for the descent operation. When the high-flow valve is closed, this additional path is not used.

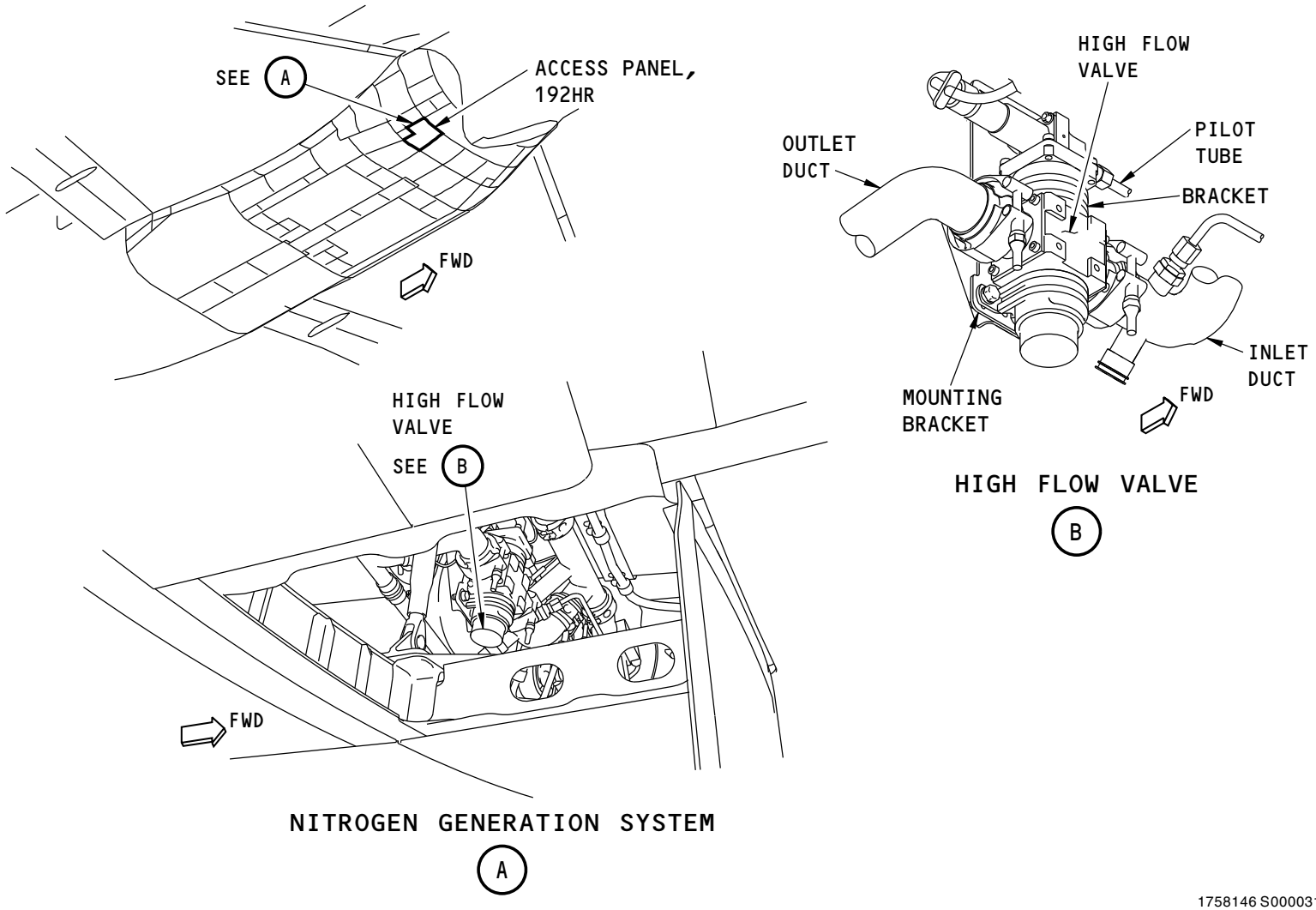
Location

The high flow valve is found on the forward section of the air separation unit (ASU) pallet via a mounting bracket. The high flow valve is found in the Forward Wing to Body Fairing Panel, 192HR.

General Description

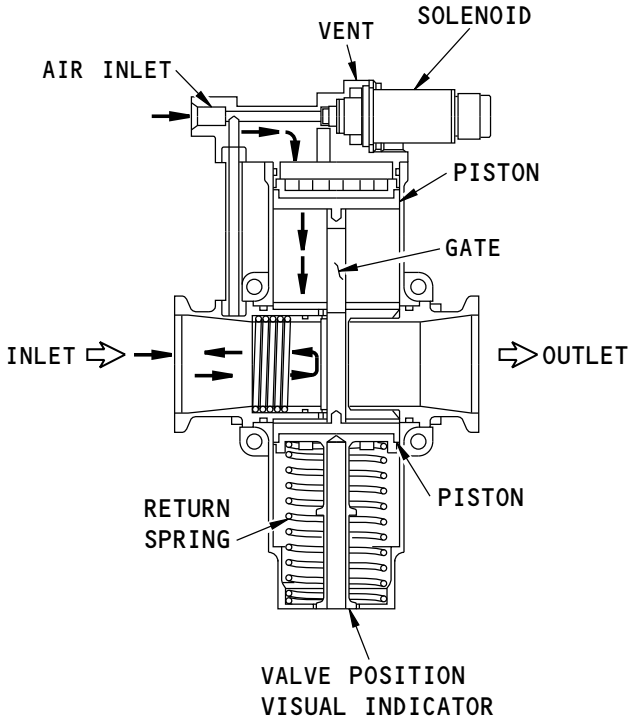
This pneumatically operated gate valve is controlled by an integrated two-way, two-position solenoid valve. The rectangular gate cross-section is supported at both ends by two cylindrical pistons that provide guiding and very low friction during operation. The low friction lets the gate be controlled by a relatively small pneumatic piston actuator that is spring-loaded to the low-flow position. The gate seal is pressure unbalanced so that inlet pressure provides additional load to seal the gate, in addition to the light loading from the spring-loaded seals to control internal leakage.

When the solenoid is energized, inlet pressure is ported to the back of the pneumatic actuator through the solenoid valve, and the pressure behind the piston chamber builds up to inlet pressure. This results is a pressure load on the piston that increases beyond the spring and friction loads, and drives the gate to the high-flow position. When the solenoid is de-energized, the valve vents pressure behind the piston through the solenoid to ambient. Pressure in the piston chamber then drops substantially, and the internal spring drives the gate to the low-flow position against the friction loads.

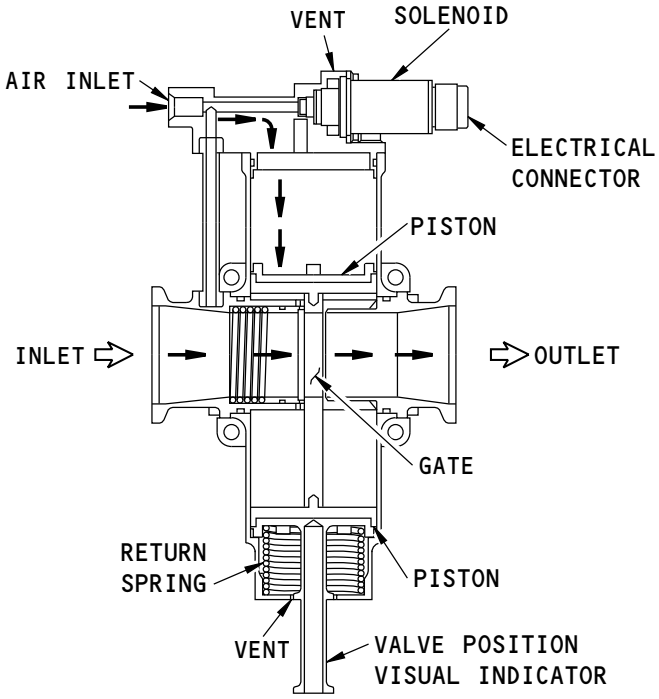


1758146 S0000317695_V1

HIGH FLOW VALVE



LOW FLOW
(CLOSED POSITION)



HIGH FLOW
(OPEN POSITION)

1758179 S0000317696_V1

HIGH FLOW VALVE - FUNCTIONAL DESCRIPTION

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OVERTEMPERATURE SHUTOFF VALVE

Purpose

The overtemperature shutoff valve (OTSOV) gives backup protection for the air separation unit (ASU) if the controller fails. This is controlled by the ASU thermal switch.

Location

The OTSOV is found aft of the outboard air separation module (ASM) located in the Underwing Fairing Panel, 196BR.

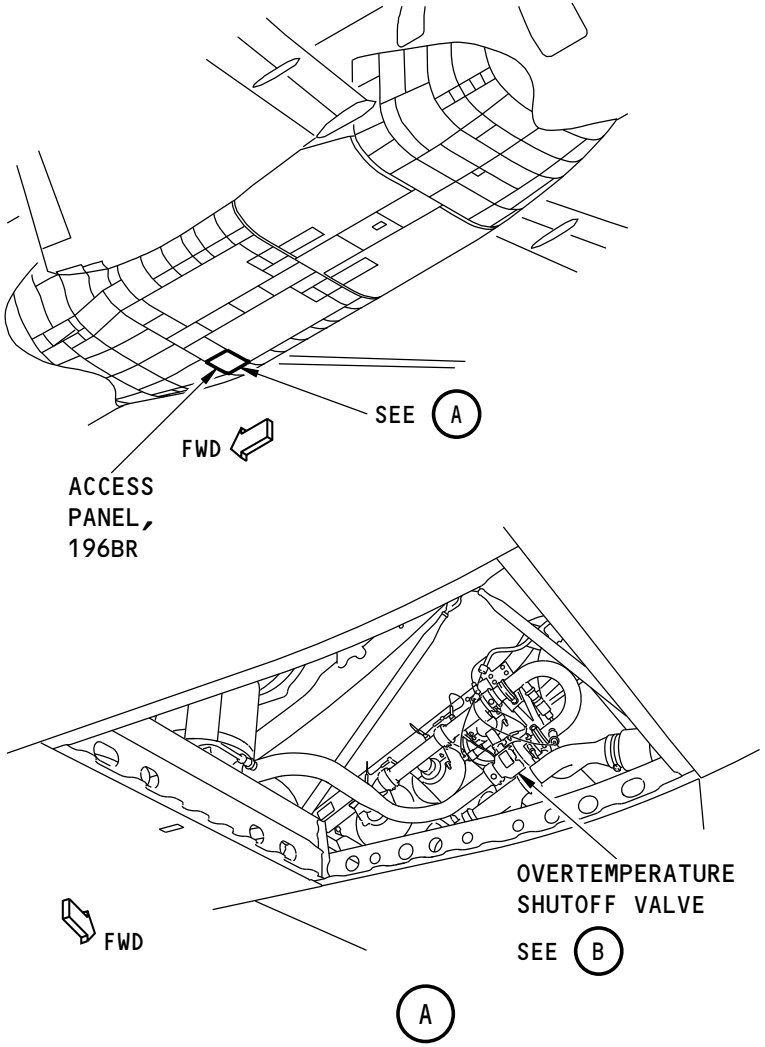
General Description

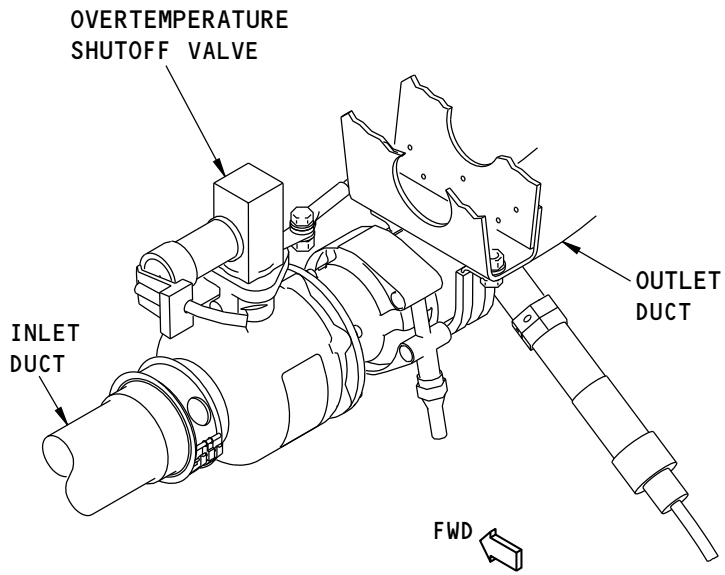
The OTSOV is electrically controlled and pneumatically operated. It is spring loaded to the closed position.

The overtemperature shutoff valve is electrically controlled and operated by differential pressure. The valve is normally closed. The controller gives a closed ground path when power is on the airplane. The ground path is open if there is no power to the system or the thermal switch is open.

When the solenoid is de-energized the ambient port is blocked. The pressures in chambers A and B are equal and the spring keeps the valve closed.

When the solenoid is energized, control chamber A is open to ambient. Pressure in control chamber B pushes on the differential area between the valve seat and the valve shutoff head seal. This pressure is more than the spring force and the valve starts to open. When the valve starts to open, the pressure pushes on the full area of the poppet. This moves the valve to the full open position.



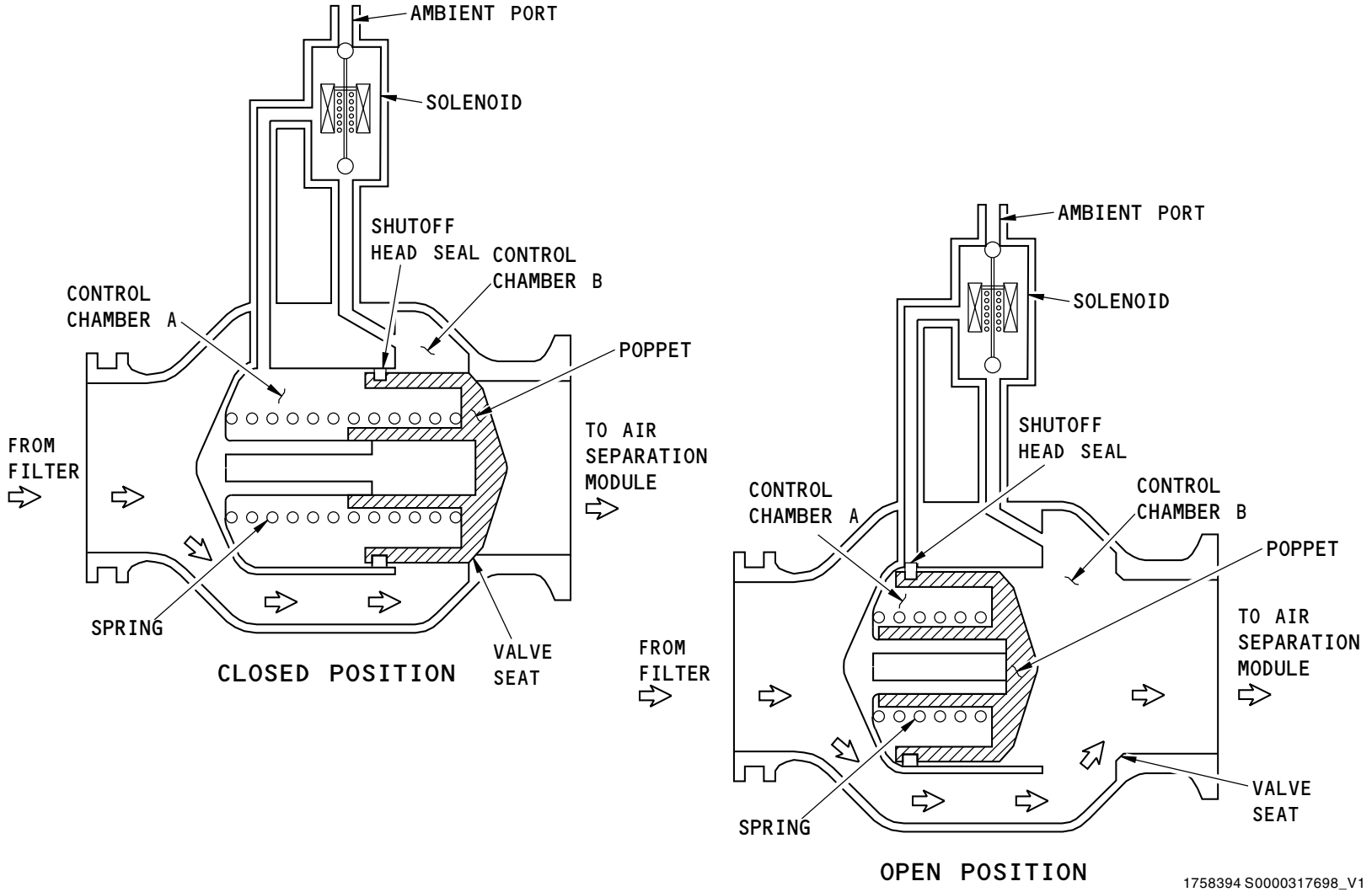


OVERTEMPERATURE SHUTOFF VALVE

B

1758369 S0000317697_V1

OVERTEMPERATURE SHUTOFF VALVE



OVERTEMPERATURE SHUTOFF VALVE - FUNCTIONAL DESCRIPTION

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OXYGEN SENSOR

Purpose

The oxygen sensor measures the oxygen content and absolute pressure of the nitrogen enriched air (NEA) supply gas and gives this data to the NGS controller for system status monitoring.

Location

The oxygen sensor is installed on the air separation unit (ASU), found in the Forward Wing to Body Fairing Panel, 192QR.

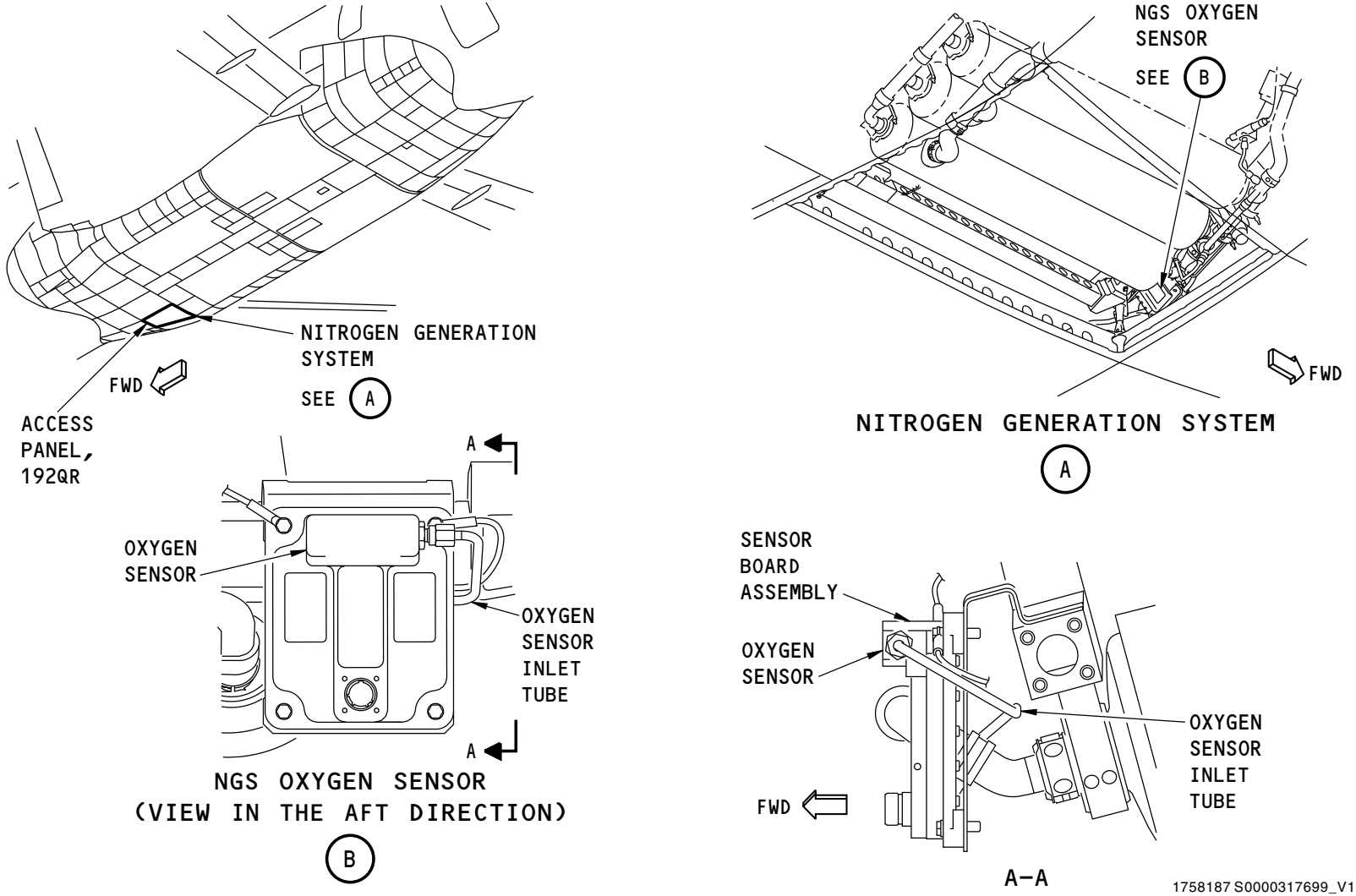
General Description

The oxygen sensor is a self-contained, solid-state gas analyzer and pressure sensor.

The oxygen sensor is installed to the ASU pallet assembly. Sample gas is directed to the pneumatic inlet port on the sensor from the common manifold downstream of the three air separation module (ASM) units and upstream of the flow orifices. The sample gas passes through a 0.005 in. (0.127 mm) orifice before being discharged to ambient.

The NGS controller controls operation of the oxygen sensor, and will command the sensor to take one reading per flight. This will usually occur in the initial part of cruise, after sufficient time for ASM warming has occurred. If conditions prevent a stable reading from being conducted during the initial cruise window, another reading attempt will be made during descent.

Oxygen sensor output is compared by the NGS controller against an expected value of oxygen concentration, based on input pressure and altitude. The NGS controller uses this comparison to identify when a significant degradation of ASM performance has occurred.



NGS OXYGEN SENSOR

AIR SEPARATION UNIT - DIFFERENTIAL PRESSURE SENSOR

Purpose

The differential pressure sensor is used by the NGS controller for BIT verification of flow through the high flow valve.

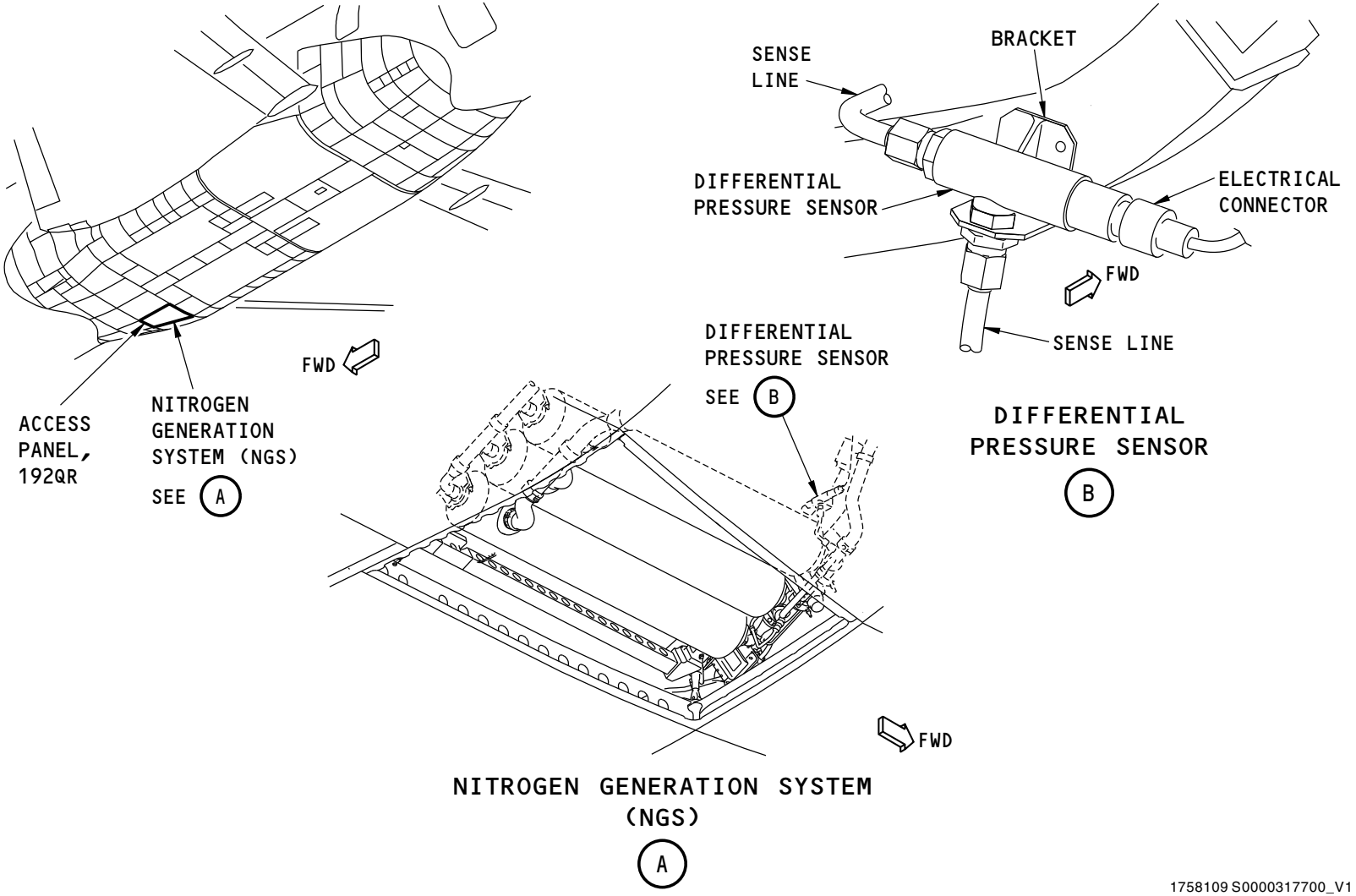
Location

The differential pressure sensor is found forward of the outboard ASM in the Forward Wing to Body Fairing Panel, 192QR.

General Description

The differential pressure sensor has hermetically sealed electronic circuitry housed in a corrosion-resistant steel shell and is boss-mounted with the fitting end threads.

The sensor has pressure sensing elements. An external voltage is supplied and output current is proportional to changes in differential air pressure. The housing uses a six-pin connector to facilitate electrical connection.



NITROGEN GENERATION SYSTEM (NGS)

A

DIFFERENTIAL PRESSURE SENSOR

B

1758109 S0000317700_V1

AIR SEPARATION UNIT - DIFFERENTIAL PRESSURE SENSOR

AIR SEPARATION UNIT - THERMAL SWITCH

Purpose

The air separation module (ASM) inlet thermal switch works in conjunction with the overtemperature shutoff valve (OTSOV) to make sure that the maximum system bleed temperature into the air separation unit (ASU) stays below 280°F (138°C).

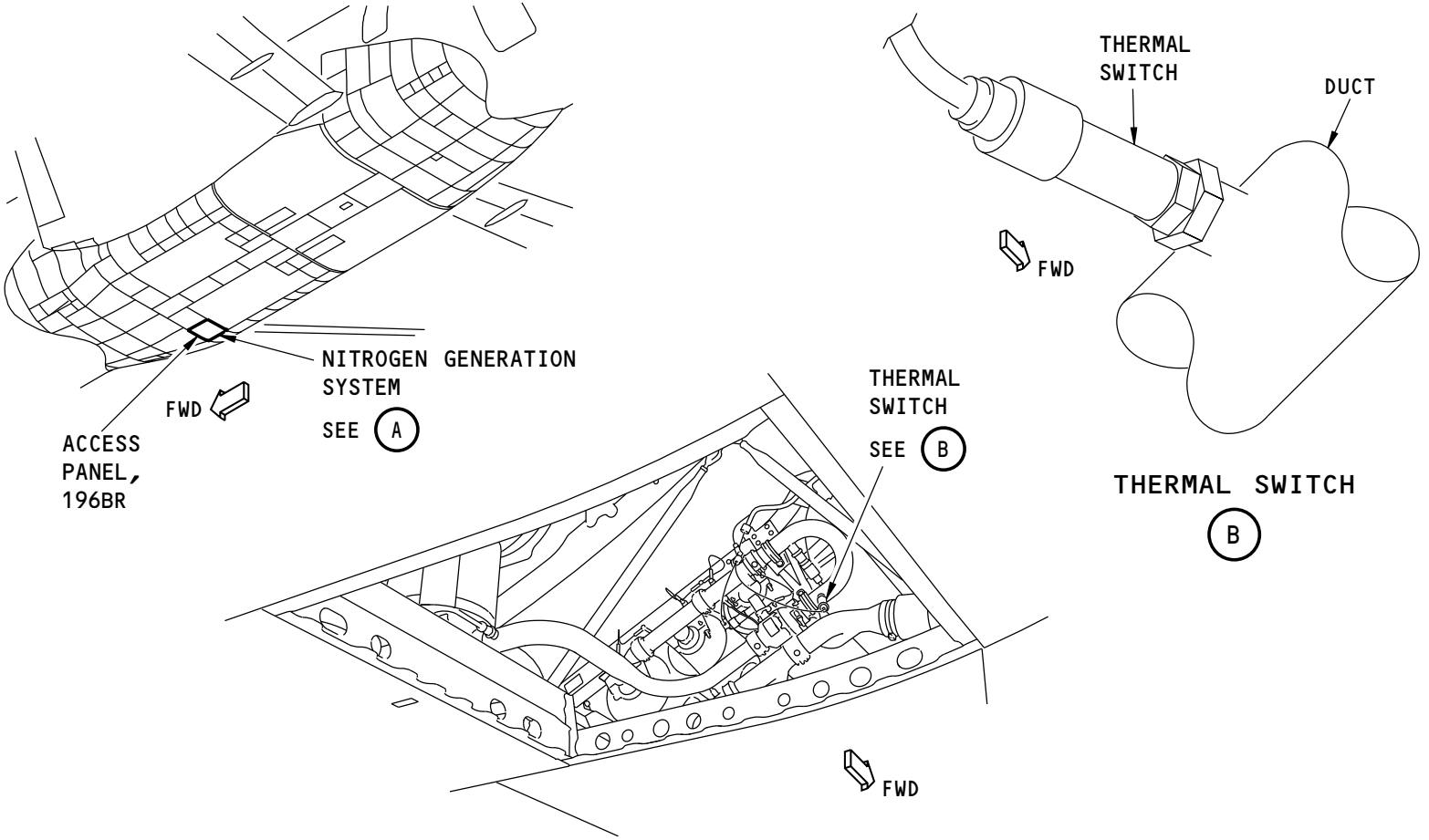
Location

The thermal switch is found aft of the outboard ASM in the Underwing to Fairing Panel, 196BR.

General Description

The thermal switch has a bimetal element enclosed in a steel probe. Electrical connections are made through a hermetically-sealed connector at the end of the switch. The switch is used to complete an electrical circuit at a predetermined temperature. The thermal switch is a non-repairable unit.

The thermal switch normally stays in the closed position and moves to the open position when the sensing temperature reaches above its temperature setpoint of 265 ±10°F (129 ±6°C). Upon actuation, the switch will reset when the temperature drops below 205°F (96°C).



1758211 S0000317701_V1

AIR SEPARATION UNIT - THERMAL SWITCH

AIR SEPARATION UNIT - TEMPERATURE SENSOR

Purpose

The temperature senor is used to measure the temperature of the bleed air into the air separation module (ASM) units.

Location

The temperature sensor is found aft of the outboard ASM in the Underwing Fairing Panel, 196BR.

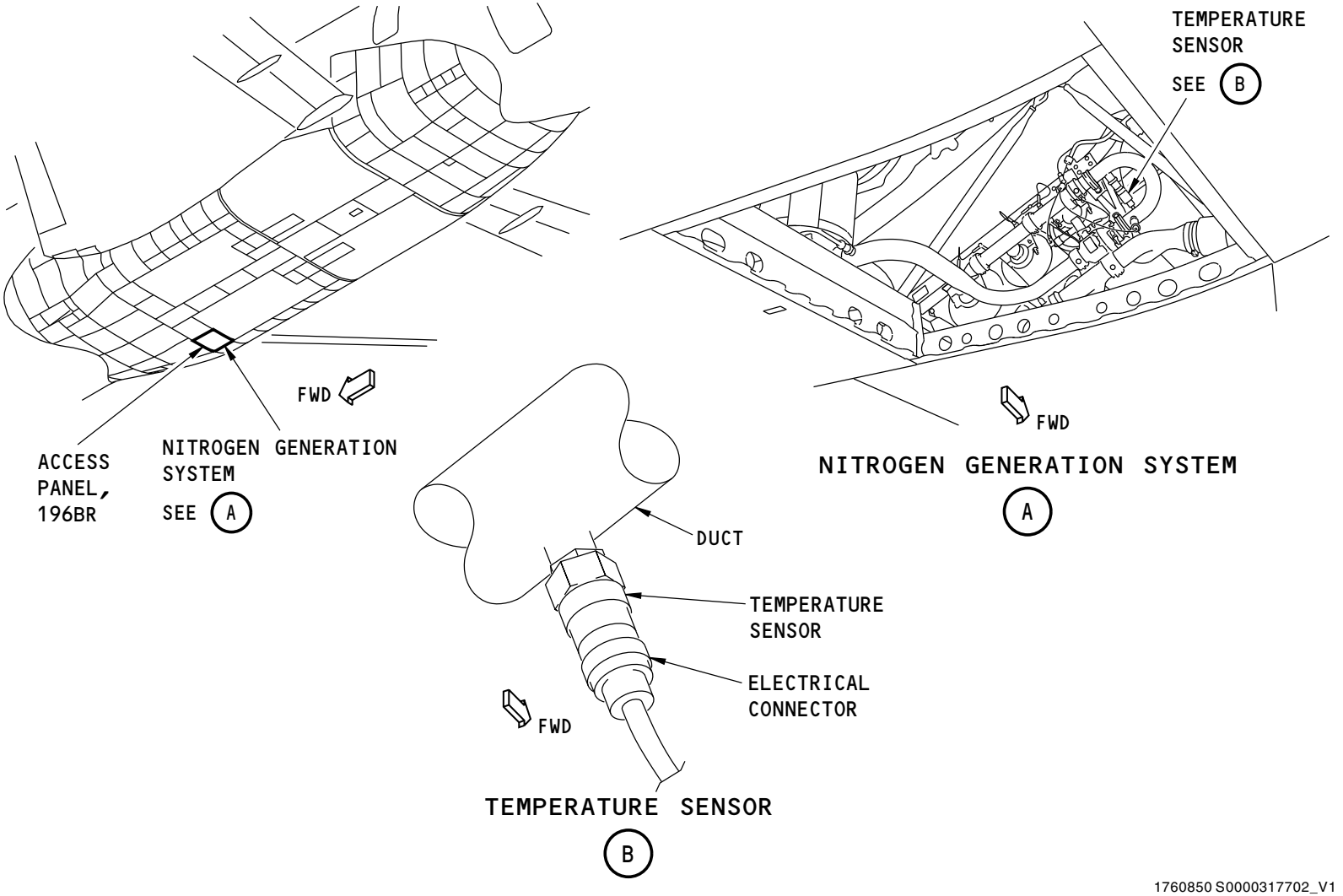
General Description

The temperature sensor is a hermetically sealed unit that has two 500 ohm platinum resistive temperature detectors housed in a corrosion-resistant stainless steel probe.

The housing is externally threaded for boss-mounting, and uses a six-pin connector to facilitate electrical connection.

The resistance of the sensing elements varies with changes in the air temperature. When installed, the sensor is electrically connected to the NGS controller. The signal, supplied by the sensor to the NGS controller, is proportionally analogous to the sensed temperature and is processed by the NGS controller in order to supply temperature regulation.

The NGS controller uses the temperature sensor for control of the temperature control valve (TCV). It is also used for system fault detection and overtemperature control.



1760850 S0000317702_V1

AIR SEPARATION UNIT - TEMPERATURE SENSOR

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NEADS - GENERAL DESCRIPTION

Purpose

The Nitrogen Enriched Air Distribution System (NEADS) supplies nitrogen enriched air from the nitrogen generation system (NGS) to the center tank.

Description

These are the components of the NEADS:

- Drain Valve
- Float Valve
- Cross Vent Check Valve
- Backflow Prevention Check Valve
- NEADS Duct
- Flame Arrestor

Drain Valve

The drain valve is between the NGS components and the NEADS. The drain valve lets you do a check for fuel or other fluid in the NEADS. You get access to the drain valve through the right ram air inlet actuator door.

Float Valve

The float valve is in the left side of the center tank between rib 1 and rib 2. It closes when the center tank is full of fuel. It opens to make sure that the nitrogen enriched air (NEA) is in specification when there is air volume in the center tank. You can get access to the float valve through the center tank access door in the left wing.

Cross Vent Check Valve

The cross vent check valve (CVCV) is in the left surge tank and is usually closed. During descent, the air pressure in the center tank must be equal to ambient air pressure. The CVCV prevents the ambient air from going into the center tank from the left surge tank. This lets the NGS pressurize the center tank with NEA. The CVCV opens to let fuel flow to the surge tank if there is an overfill event.

Backflow Prevention Check Valves

The backflow prevention check valve prevents fuel flow back into the air separation module (ASM). The vent channel is open to the air bubble in the tank. Fuel can go into the channel during these conditions:

- The system fills the tank to volumetric top-off and is inactive for long periods of time.
- Warm weather expands the fuel in the tank.
- You refuel the airplane when it is not level.
- Rejected takeoff
- Ground maneuvers

The primary backflow prevention check valve is in the right side of the center tank. You can get access to it through the center tank access door in the right wing.

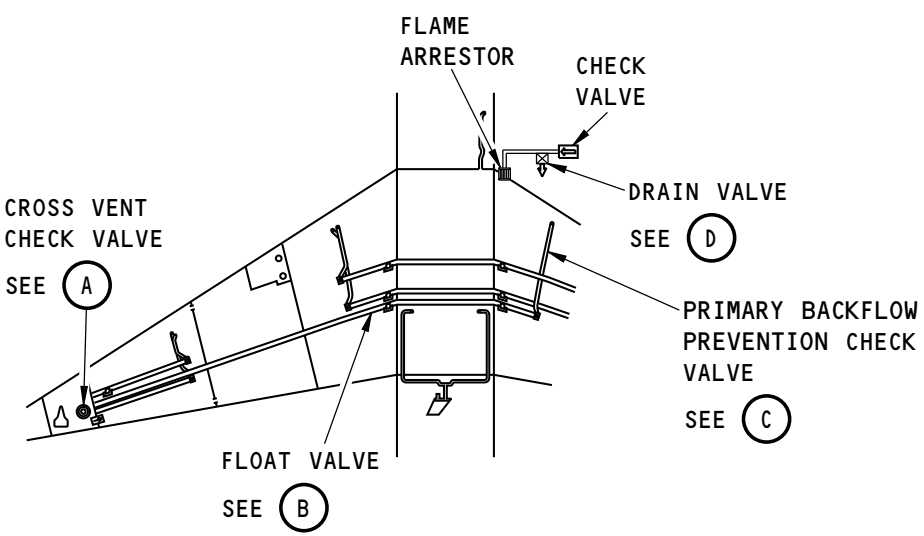
The secondary backflow prevention check valve is forward of the Air Separation Unit (ASU). It is in the right forward wing to body fairing panel, 192HR.

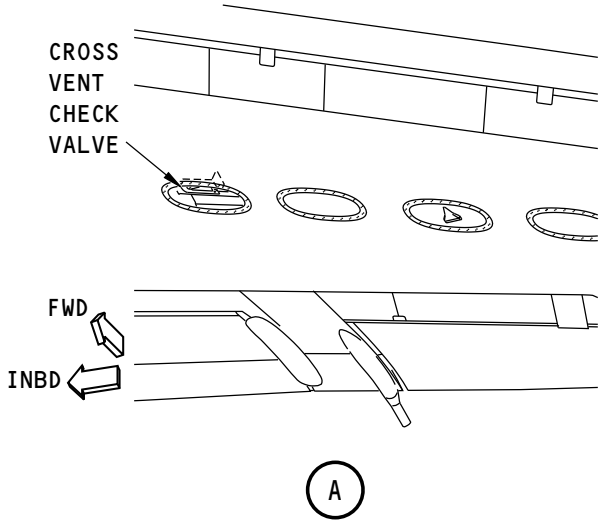
NEADS Duct

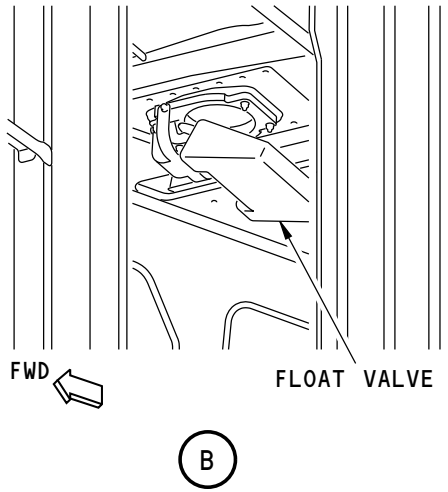
The NEADS duct consists of aluminum tubes and fittings. It transports the NEA from the NGS to the center tank.

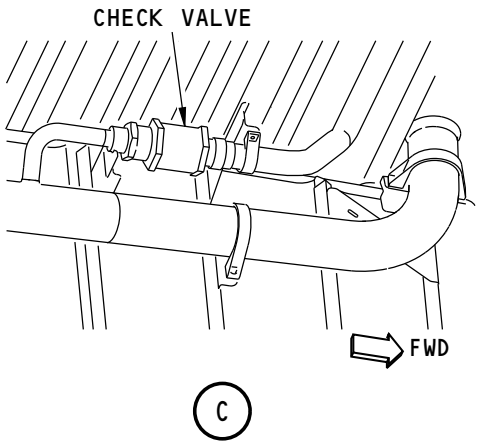
Flame Arrestor

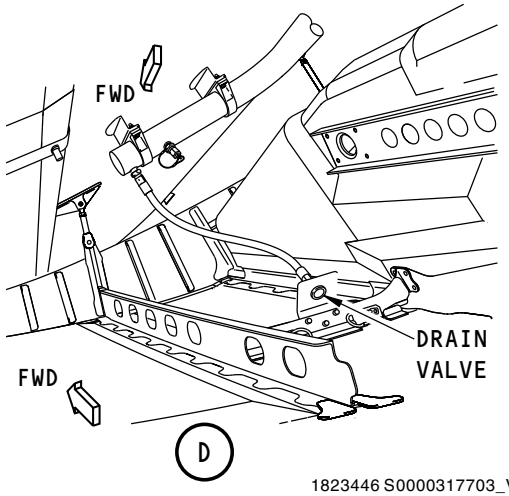
The flame arrestor is an in-line honeycomb unit. It gives protection against lightning caused ignition. It is installed into a bulkhead fitting and attached to the rear spar of the center tank. You can get access to the flame arrestor through the right inboard fixed leading edge panel.











1823446 S0000317703_V1

NEADS - GENERAL DESCRIPTION

NEADS - COMPONENT LOCATION - 1

General

The components of NEADS are in the right fairing panels and in the fuel distribution system.

Components - Right Fairing Panel

These components are in the right fairing panel:

- Ground service equipment O2 port
- Secondary backflow prevention check valve
- Drain valve

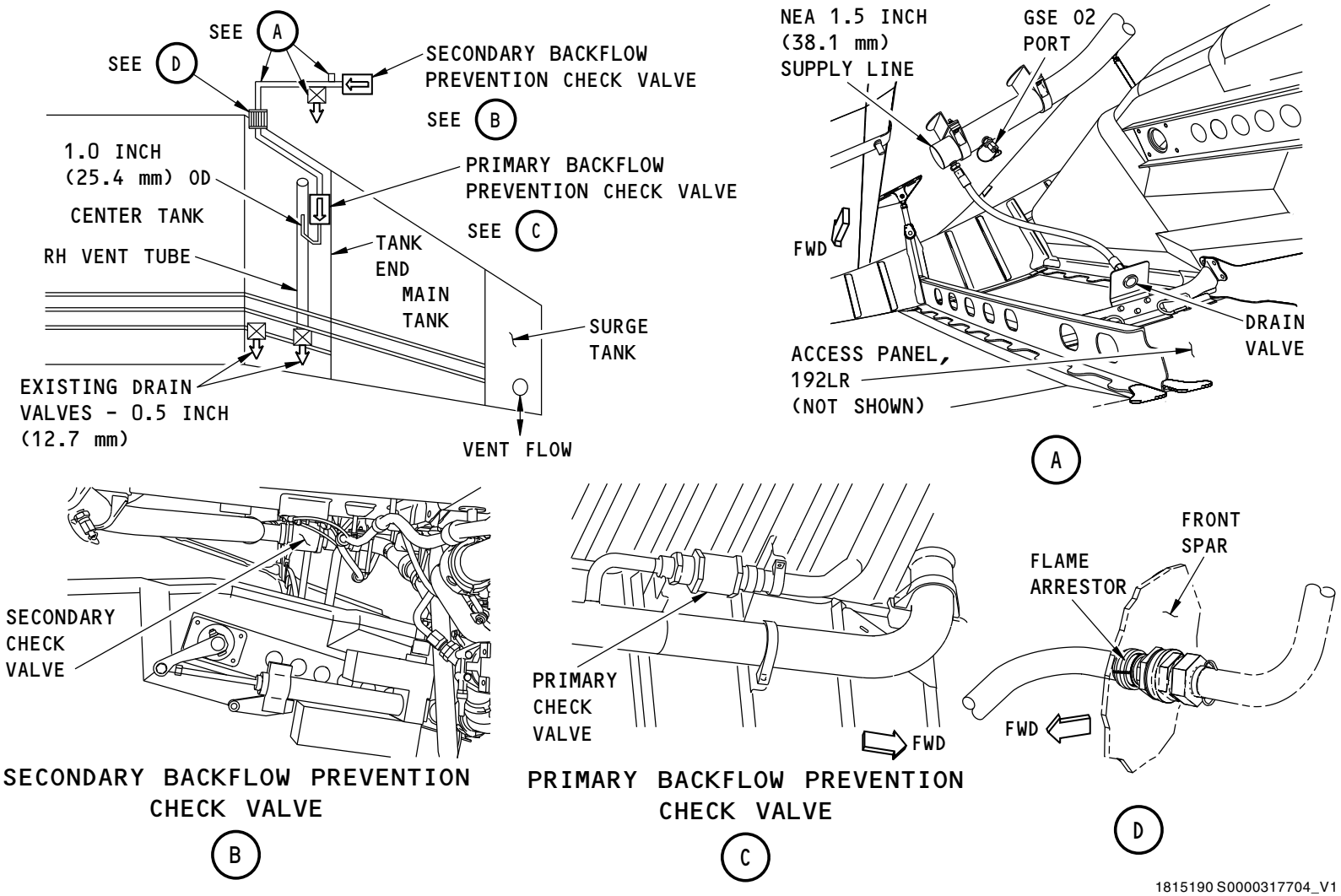
Components - Right Inboard Fixed Leading Edge Panel

These components are in the right inboard fixed leading edge panel attached to the center tank front spar:

- NEA 1.5 in. (3.8 cm) supply line
- Flame arrestor

Components - Center Tank - Right Side

- Primary backflow prevention check valve



1815190 S0000317704_V1

NEADS - COMPONENT LOCATION - 1

NEADS - COMPONENT LOCATION - 2

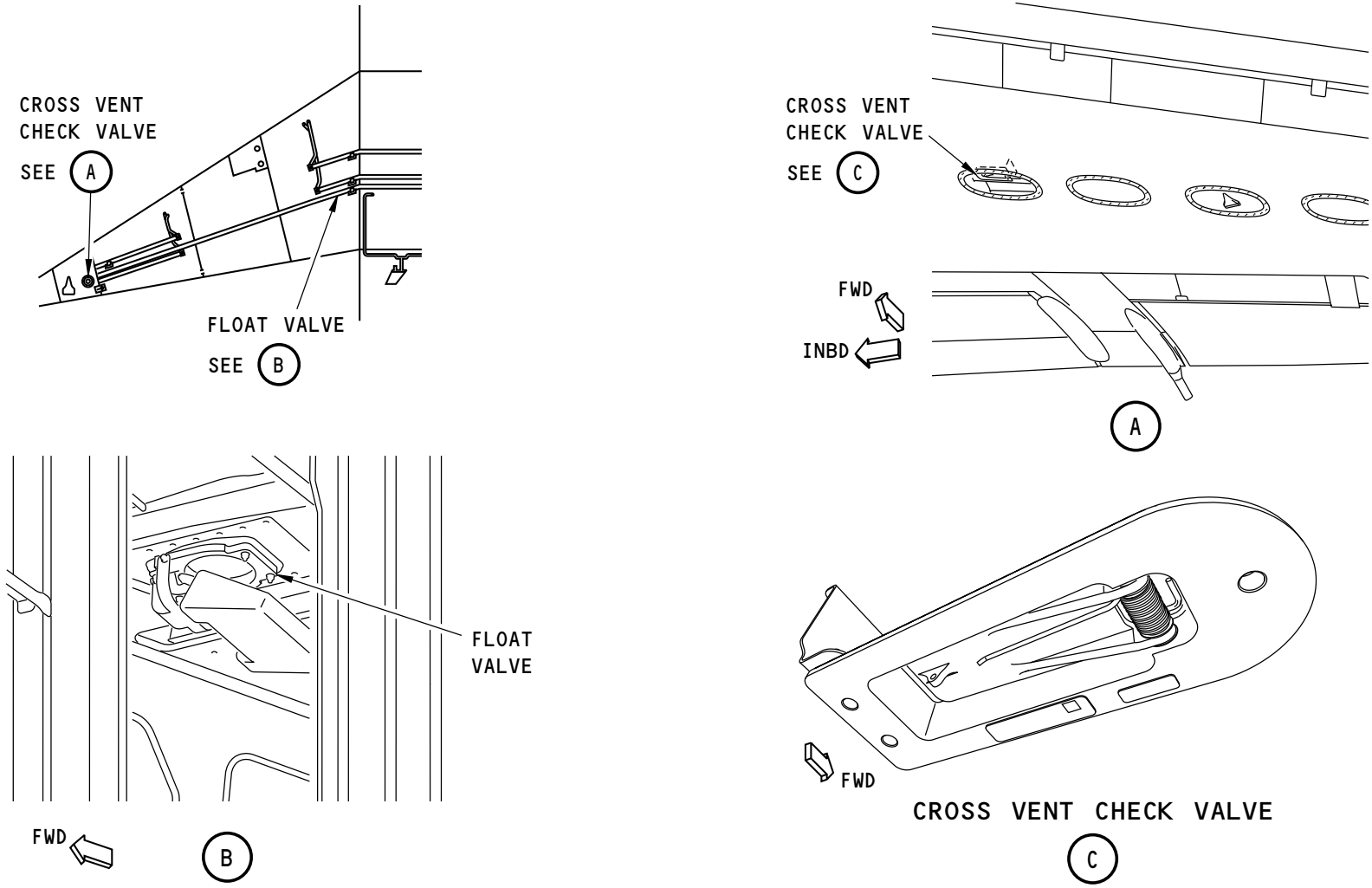
General

The left side of the center tank has these components:

- Vent channel
- Float Valve

The left surge tank has these components:

- Vent channel
- Cross vent check valve (CVCV)



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NEADS - COMPONENT LOCATION - 2

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NITROGEN GENERATION SYSTEM CONTROLLER

Purpose

The nitrogen generation system (NGS) controller collects data from the airplane systems and sends signals to operate the components of the NGS.

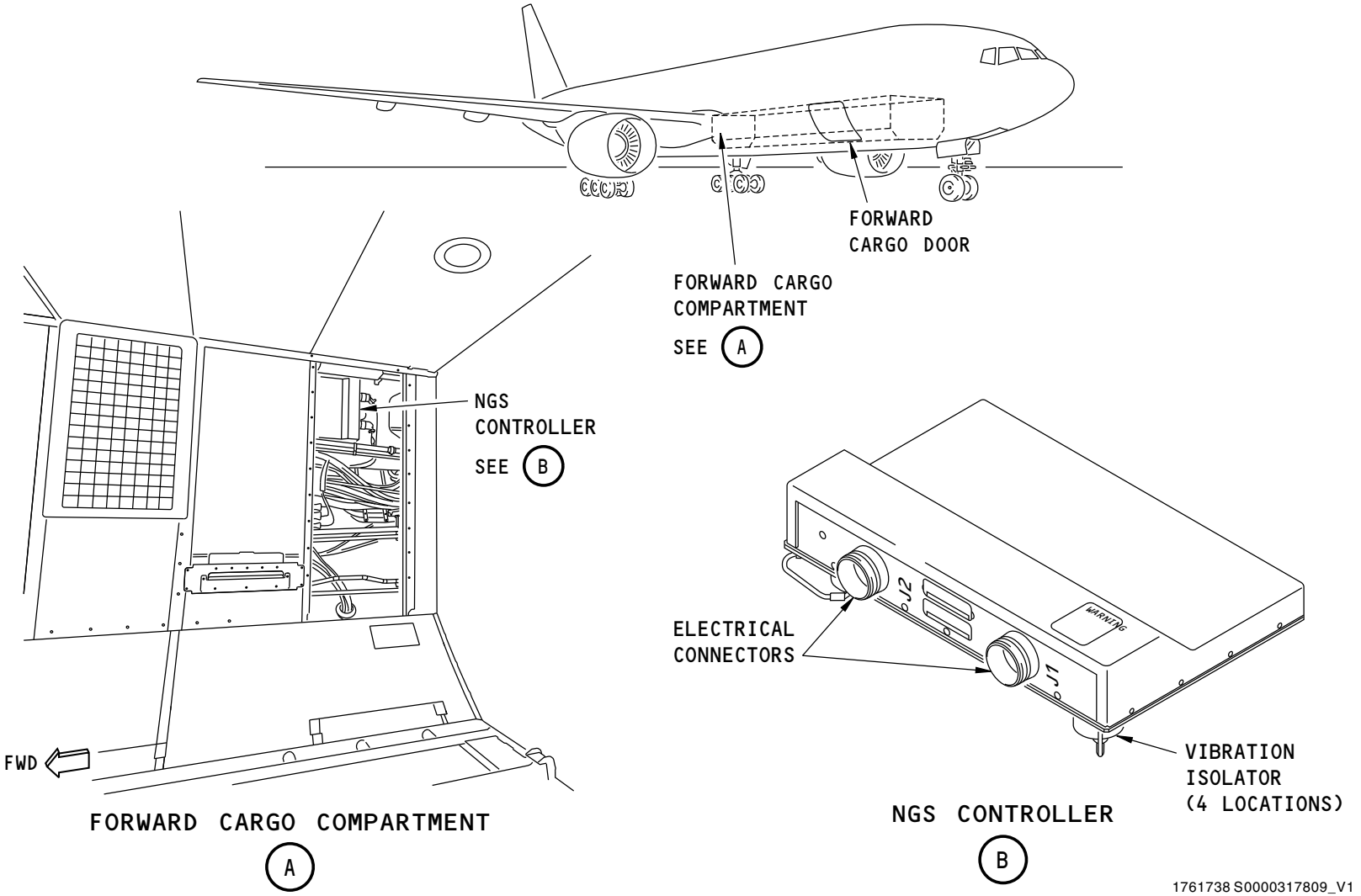
Location

The NGS controller is located in the aft section of the forward cargo compartment on the right side.

General Description

The controller has a one card assembly with an integrated power supply and a microcontroller. These installed components are in a metal chassis. The chassis is attached to the airplane structure by vibration isolators.

The controller has two electrical connectors on the front of the case.



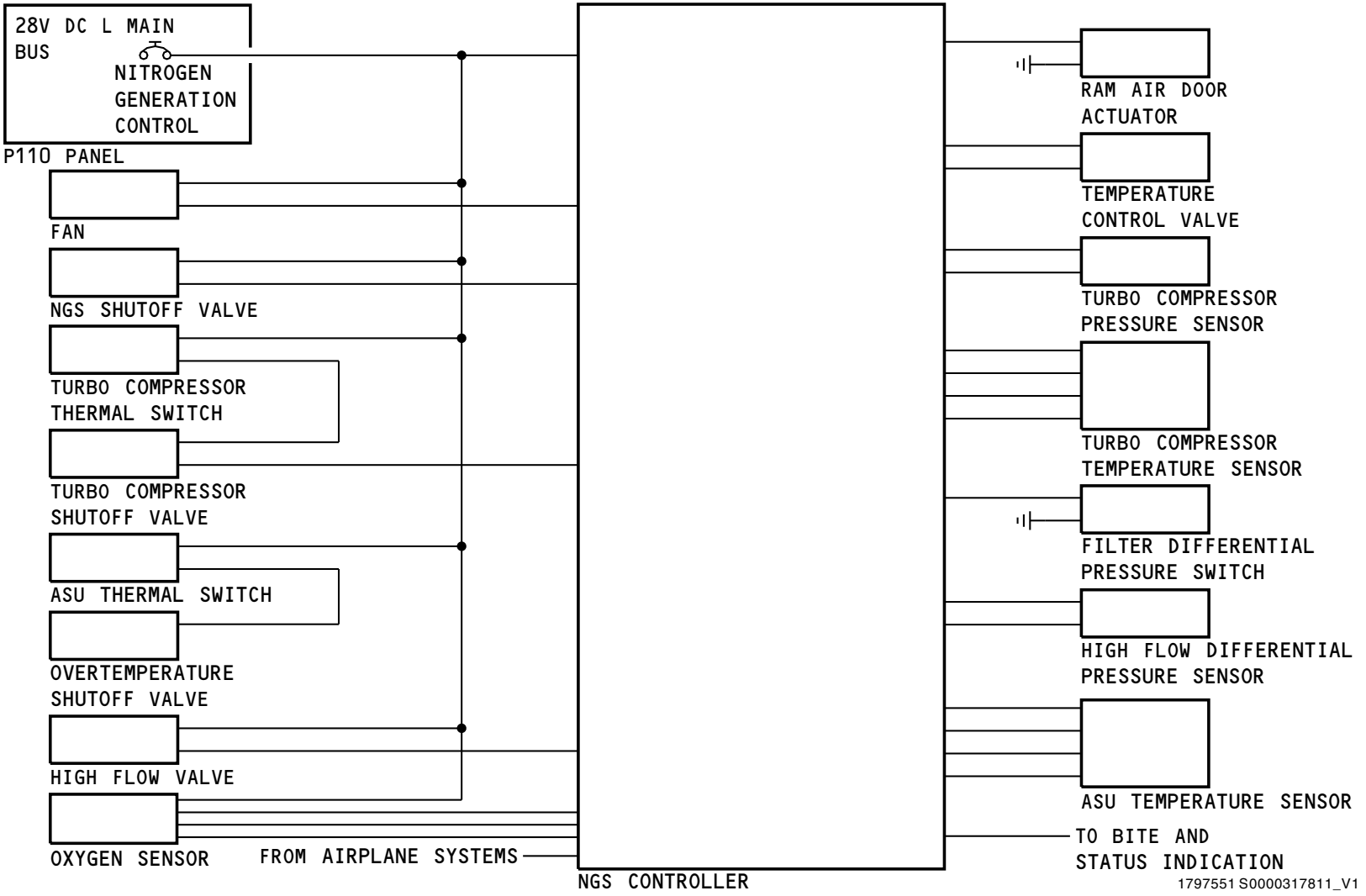
NITROGEN GENERATION SYSTEM - CONTROLLER

NGS CONTROLLER - FUNCTIONAL DESCRIPTION

Functional Description

The NGS controller does these functions:

- Modulates the temperature control valve to control the temperature of the bleed air that goes into the air separation module
- Modulates the ram air door actuator to control the quantity of ram air that goes into the thermal control unit
- Commands the NGS shutoff valve to open or close
- Commands the overtemperature shutoff valve to open or close
- Commands the turbo compressor shutoff valve to open or close
- Commands the high flow valve to open or close
- Monitors overtemperature conditions
- Sends indications to the BITE display unit
- Senses decreased flow
- Gets data from the differential pressure sensor
- Does the electrical built-in-test
- Supplies RS422 communication to download software and monitor controller data
- Records flight data in non-volitile memory
- Monitors air separation module performance testing by the oxygen sensor



NGS CONTROLLER - FUNCTIONAL DESCRIPTION

NGS CONTROLLER - DISCRETE INPUTS

General

The NGS controller gets discrete inputs from these airplane sources to regulate when and how the system works:

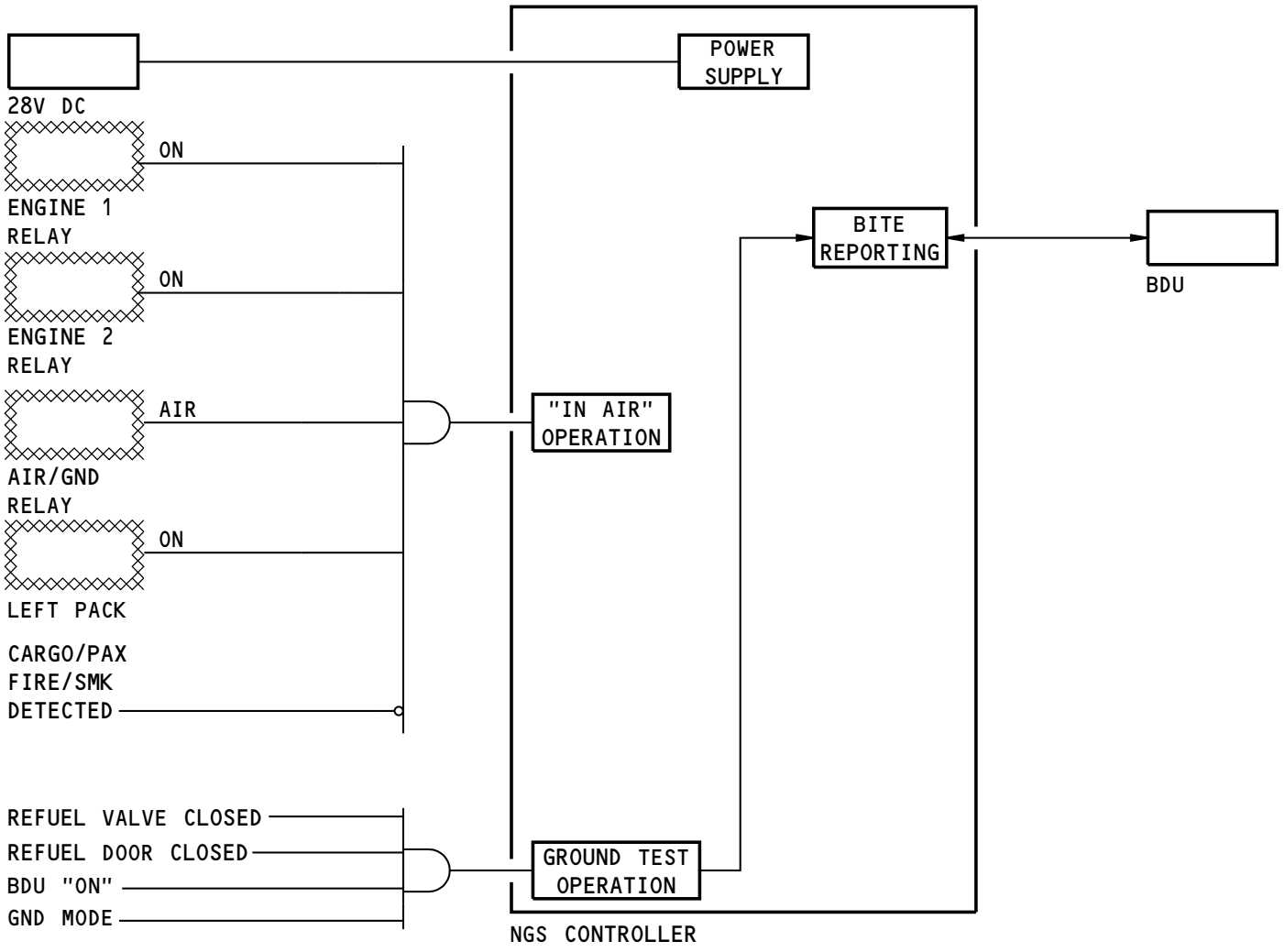
Module/System	Monitors	NGS Operating Mode
Cargo Smoke Detection and Fire Suppression Module	Cargo and/or Main Deck for Smoke and/or Fire	True = OFF
Pack Flow Control and Shutoff Valve	AC pack for an overheat condition	True = OFF
System 1 Air Ground Relay	Weight on Wheels - On Ground	True = OFF
Engine 1 and 2 Running Relays	Weight on Wheels - On Ground	True = OFF
Center Tank Refuel Valve	Valve Position - Open	True = OFF

Analog discrete inputs tell the NGS controller the position of an airplane system valve or the electrical condition of a connection from a sensor (open or ground). The controller opens the NGS shutoff valve during normal flight conditions and lets bleed air into the air system. The NGS controller opens the NGS shutoff valve when all of these conditions are met:

- Airplane is in the air
- Both engines are running
- Cargo smoke detection and suppression module is normal
- The air conditioning packs are not overheated
- The center tank refueling valve is closed

When the NGS shutoff valve is closed, the system is OFF. The NGS shutoff valve is closed if any one of these conditions exist:

- Airplane is on the ground and not in test mode. Unless power to the NGS controller is cycled, such as for the first flight of the day, and the ambient temperature is above 60°F (16°C), then the NGS will come ON and operate for 20 minutes.
- Either engine is OFF in flight
- Fire or smoke detection in cargo or main deck areas
- Left/Right air conditioning pack overheat
- The center tank refueling valve is open



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NGS CONTROLLER - DISCRETE INPUTS

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NGS INDICATION - BITE DISPLAY UNIT

Purpose

You use the BITE display unit to troubleshoot the nitrogen generation system components.

Location

The BITE display unit is located in the ECS Low Pressure Connection Door, 196CR.

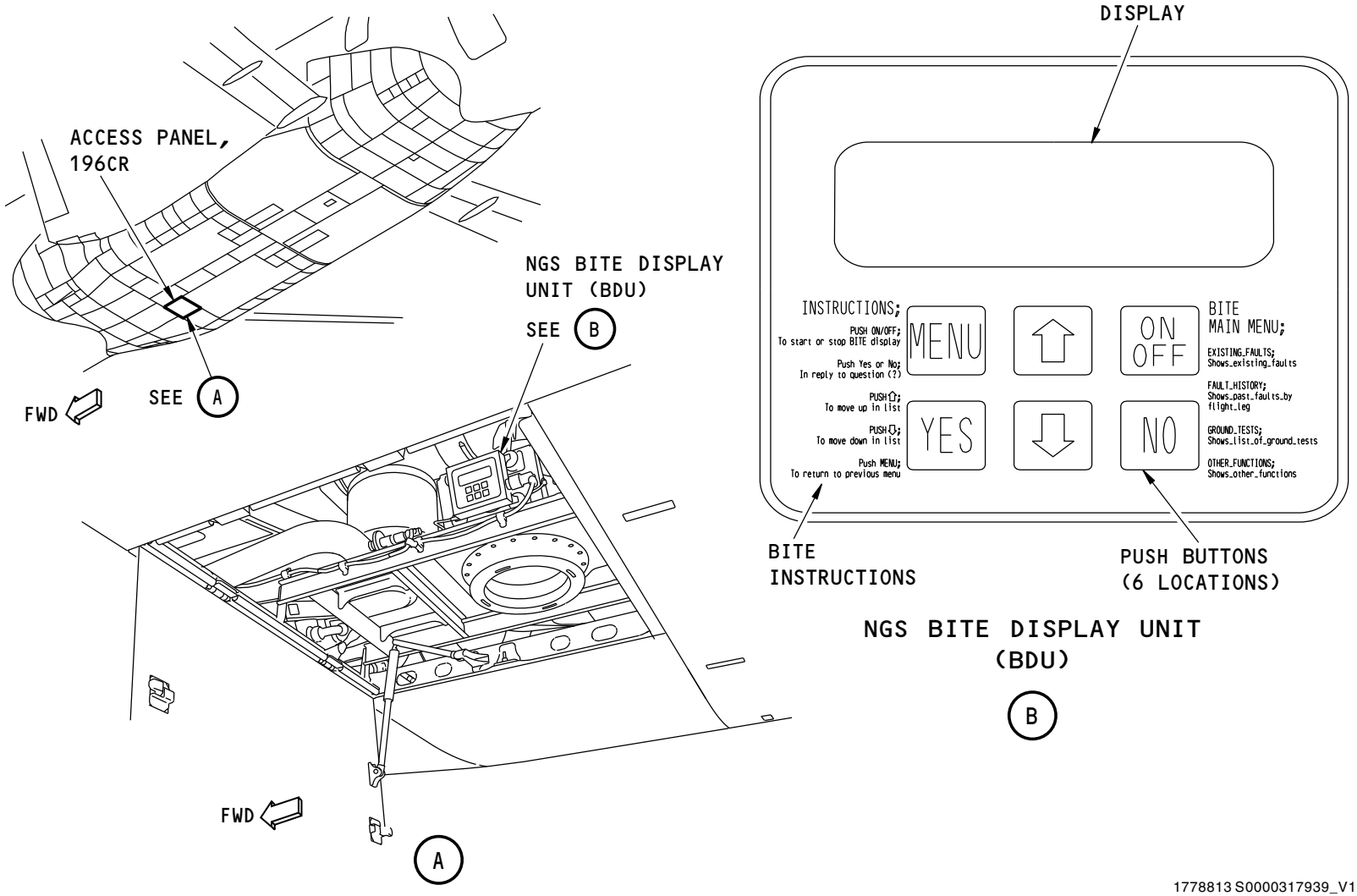
BITE

The BITE display unit gives you access to these menus:

- EXISTING FAULTS?
- FAULT HISTORY?
- GROUND TESTS?
- OTHER FUNCTIONS?

These are the functions of the BITE display unit pushbuttons:

- You use the ON/OFF button to start or stop the BITE display unit.
- You use the MENU button to start the BITE menus. You can push the MENU button to move up one level in the menus. The MENU button is also used to immediately stop a test.
- You use the YES button to respond to a question. The YES button also starts a test.
- You use the NO button to respond to a question.
- You use the Up arrow to move up through a menu or the result of a test.
- You use the Down arrow to move down through a menu or the result of a test.



1778813 S0000317939_V1

NGS INDICATION - BITE DISPLAY UNIT

NGS INDICATION - BITE

General

The nitrogen generation system does these BITE functions:

- Continuous monitor
- BITE tests

Continuous Monitor

The continuous monitor function monitors the controller for correct operation. When the controller has an internal failure, the event is kept in fault history.

BITE Tests

BITE does tests on components and sensors that have an interface with the nitrogen generation system. It has these functions:

- Quick system test
- NGS LRU self-test
- Does tests of sensors that have an interface with the nitrogen generation system
- It does tests to show that functions are in specification.
- Aid for fault isolation

The BITE display unit has a key pad with six buttons. It has a vacuum flourescent display with two lines of sixteen characters for each line.

BITE Operation

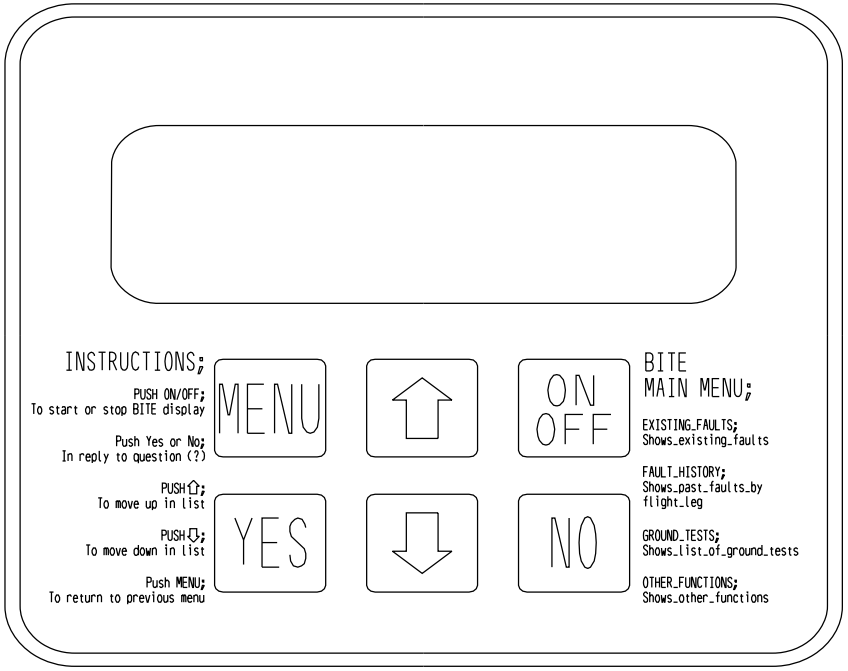
To start the BITE, push the ON/OFF key on the BITE display unit. EXISTING FAULTS? shows as the first menu item. Push the YES key to answer questions and to move down in the selected menu item on the display. Push the NO or down arrow key to see the next menu item. In some lists, TOP OF LIST or END OF LIST shows when you move to the top or bottom of the list. Push the MENU key to go out of a menu and to move up one level to the previous menu.

Main Menu

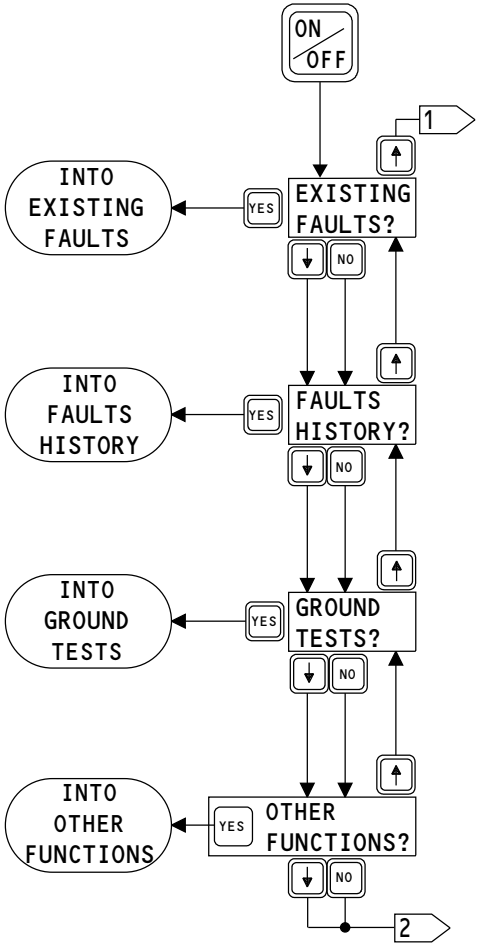
These are the BITE main menu selections:

- EXISTING FAULTS?
- FAULTS HISTORY?
- GROUND TESTS?
- OTHER FUNCTIONS?

When BITE starts, EXISTING FAULTS? shows. Push the YES button to select this menu. Use the NO key ot the down arrow key to move to the next menu selection.



BITE DISPLAY UNIT



1 SHOWS TOP OF LIST

2 SHOWS END OF LIST

1760072 S0000317940_V1

NITROGEN GENERATION SYSTEM - BITE

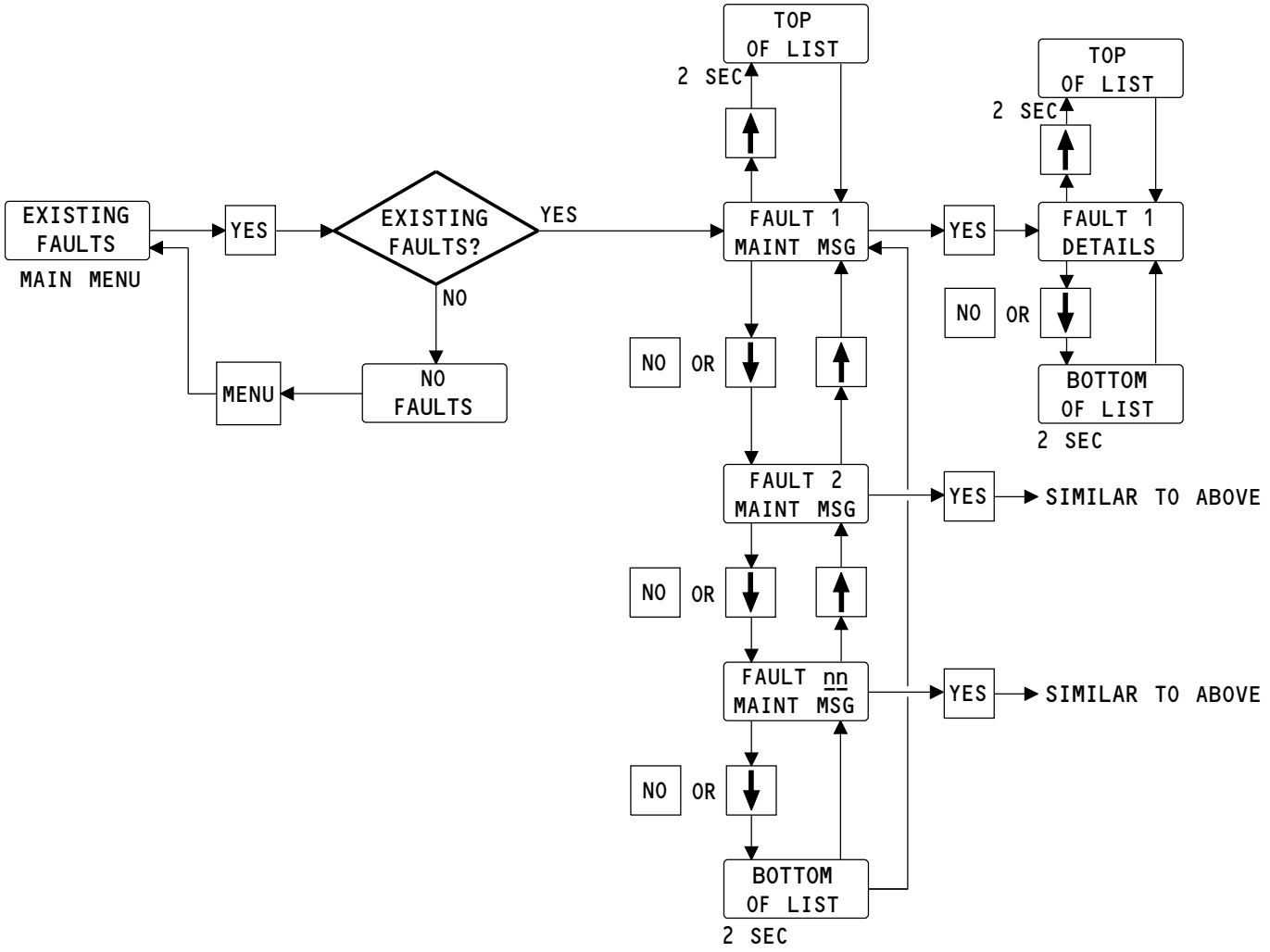
Existing Faults

The EXISTING FAULTS? menu shows faults that are present in the system. From the EXISTING FAULTS? menu you can select faults to examine. Faults are maintenance messages. Fault details give more data about the problem.

From the EXISTING FAULTS? menu, push the YES button. If there are no faults, the display shows NO FAULTS. Push the MENU button to go back to the main menu.

If there are faults, the newest one shows on the display. To see the next previous fault, push the NO or the down arrow button. After the last (or only) fault, the display shows BOTTOM OF LIST for 2 seconds.

To see the fault details for one of the faults, push the YES button. The display shows the details for that fault. If you push the NO button, or the down arrow, you see the next detail for that fault. If there are no more details, the display shows BOTTOM OF LIST for 2 seconds.



1759842 S0000317941_V1

NGS INDICATION - BITE - EXISTING FAULTS

Fault History

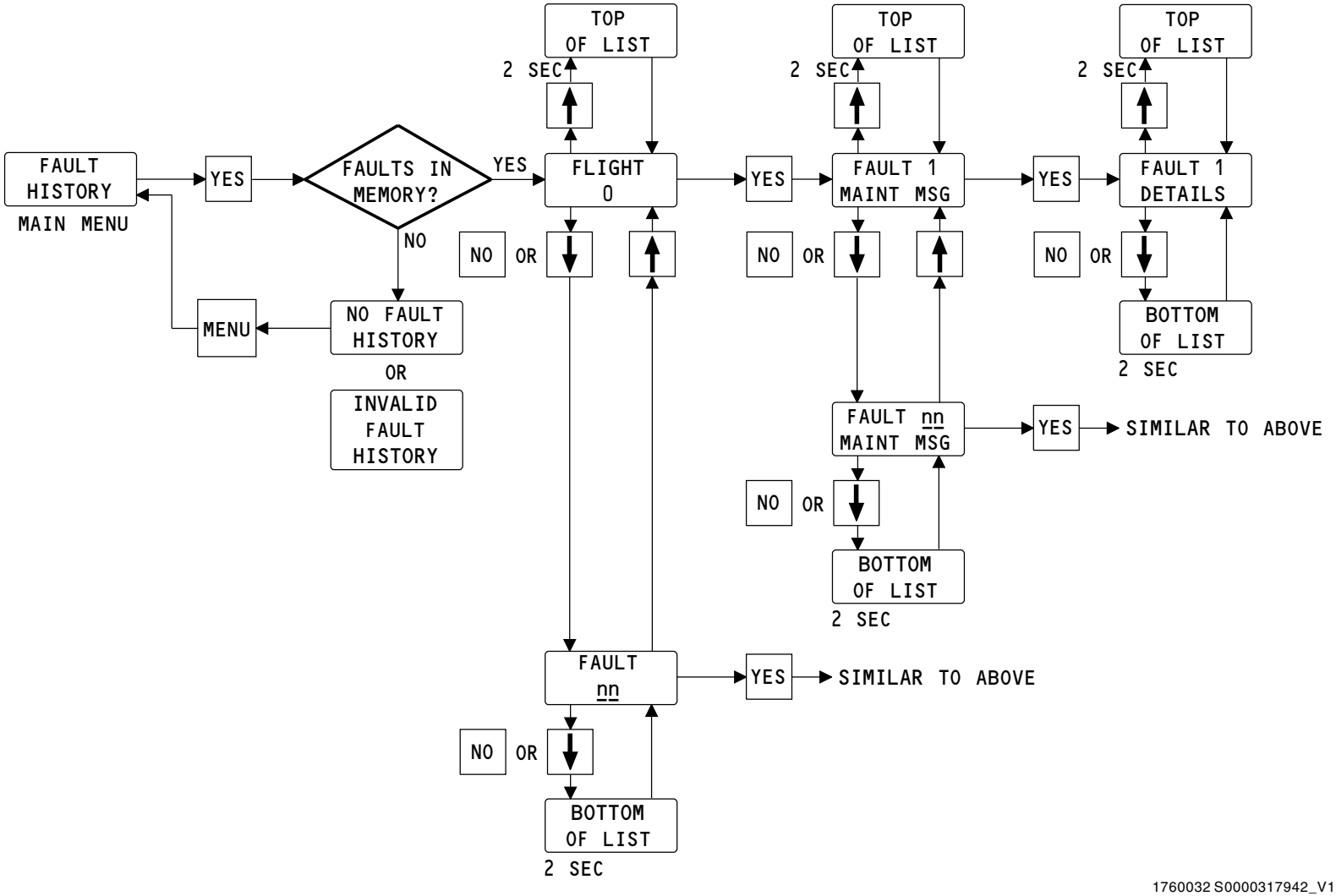
FAULT HISTORY? shows the faults that are in the memory, and that have not been cleared.

From the FAULT HISTORY? menu, push the YES button. If there are no faults in memory, NO FAULT HISTORY shows on the display. Push the MENU button to go back to the main menu.

If there are faults, the display shows 00 for the most recent fault. To show the next previous flight leg, push the NO button or the down arrow. The display shows 01 as the next previous flight leg. If there are no more faults in memory, the display shows BOTTOM OF LIST for 2 seconds. The controller can have as many as 1000 flight legs in memory.

Each flight leg can have faults and details. To show a fault for a flight leg, push the YES button. The display shows the fault. If you push the NO button or the down arrow, the display shows the next fault. If there are no more faults, the display shows BOTTOM OF LIST for 2 seconds

To show the details for each fault, push the YES button. If you want to see more fault details, push the NO or the down arrow button. If there are no more fault details, the display shows BOTTOM OF LIST for 2 seconds.



1760032 S0000317942_V1

NGS INDICATION - BITE - FAULT HISTORY

Ground Test

GROUND TEST? does a series of tests on the nitrogen generation system.

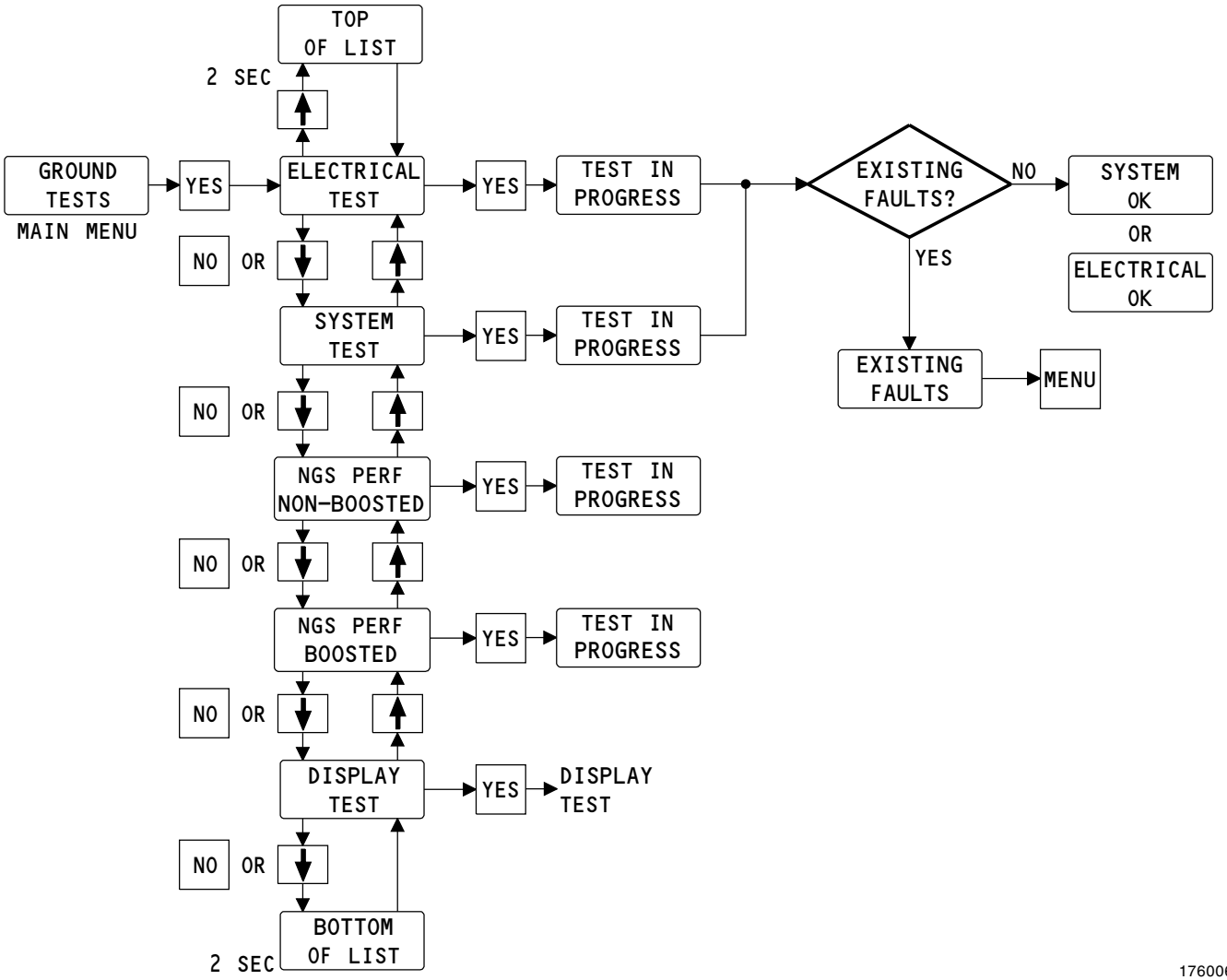
From the GROUND TEST? menu push the NO or the down arrow button. The display shows these tests:

- ELECTRICAL TEST
- SYSTEM TEST
- GSE PRI (non-boosted mode)
- GSE ALL (boosted mode)
- DISPLAY TEST

When you select a test, the display shows TEST IN PROGRESS.

If there is no fault, the display shows SYSTEM OK.

If there is a fault after TEST IN PROGESS, the display shows nn EXIST FAULTS for 2 seconds. It then goes to the EXISTING FAULTS? menu.



1760069 S0000317951_V1

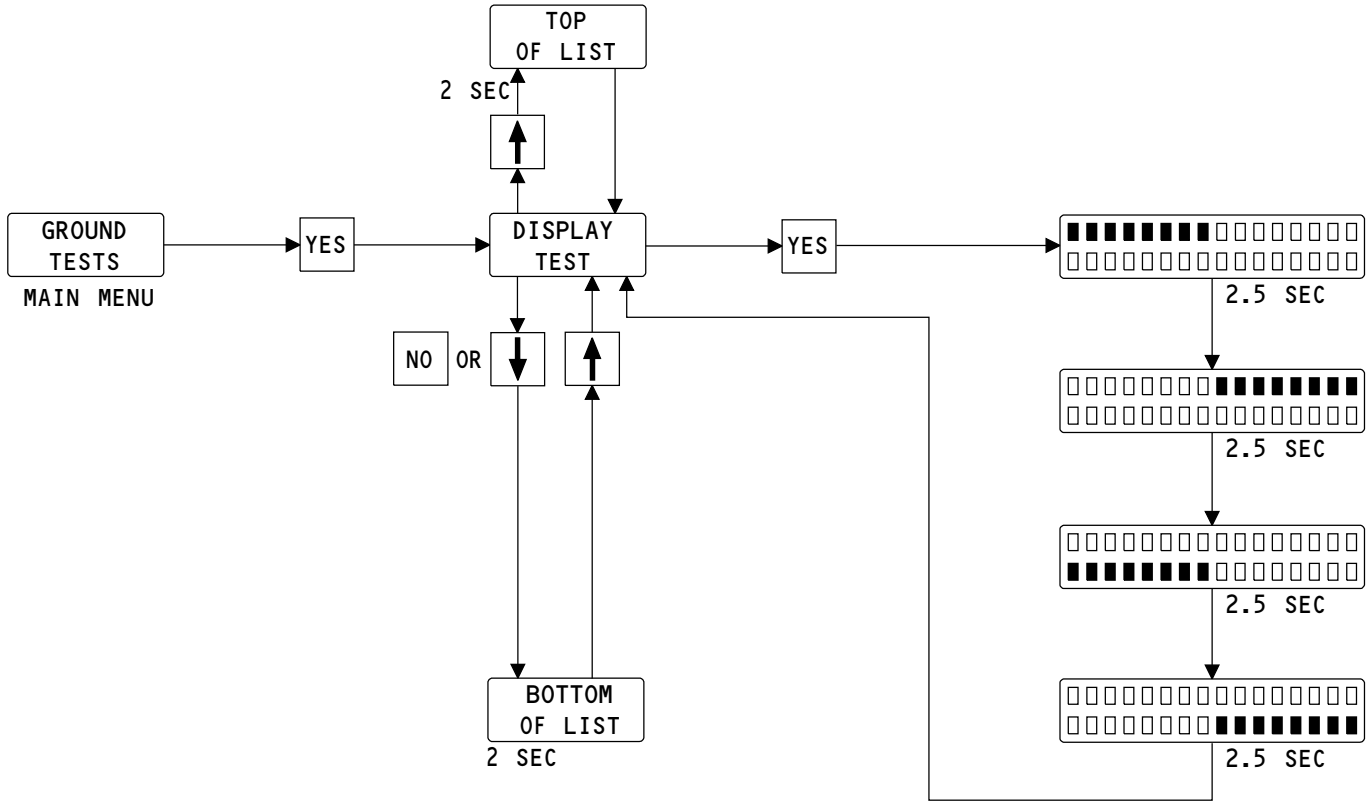
NGS INDICATION - BITE - GROUND TESTS

NGS INDICATION - BITE - DISPLAY TEST

Display Test

DISPLAY TEST does a test of all 32 digits of the vacuum florescent display (VFD).

From the GROUND TEST menu, push the YES button. The display shows DISPLAY TEST. Push the YES button to start the test. Four digits at a time come on for 2.5 seconds. After the test is complete, the display shows DISPLAY TEST.



LEGEND:

■ BDU LIGHT ON
□ BDU LIGHT OFF

1760070 S0000317960_V1

NGS INDICATION - BITE - DISPLAY TEST

NGS INDICATION - BITE - OTHER FUNCTIONS

Other Functions

OTHER FUNCTIONS shows special details of the nitrogen generation system.

From the OTHER FUNCTIONS menu, push the NO or the down arrow button. The display shows these selections:

- SYSTEM CONFIGURATION
- I/O MONITOR

SYSTEM CONFIGURATION

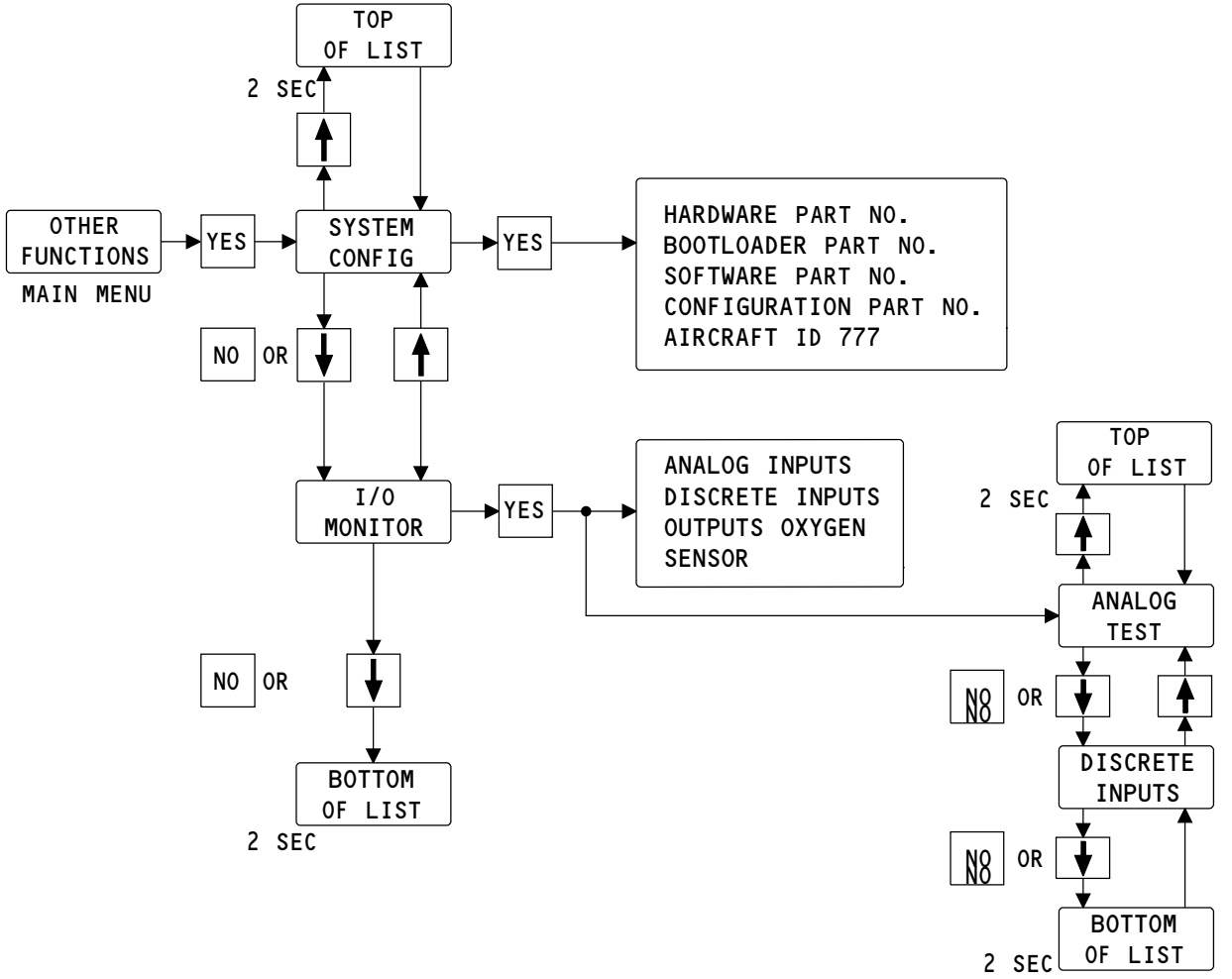
The system configuration menu gives these selections:

- Hardware part number
- Bootloader part number
- Software part number
- Configuration part number
- Aircraft ID 777.

I/O MONITOR

The I/O MONITOR gives this data:

- Analog inputs
- Oxygen sensor.



1778925 S0000317968_V1

NGS INDICATION - BITE - OTHER FUNCTIONS