CHAPTER

47

Inert Gas System

CHAPTER 47
INERT GAS SYSTEM

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NITROGEN GENERATION SYSTEM - INTRODUCTION

Purpose

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

General

The NGS system does these functions:

- Controls the bleed air pressure into the NGS system
- Changes the ozone from the bleed air to oxygen
- Decreases the bleed air temperature
- Removes contamination from the conditioned air
- Removes oxygen (O_2) from the conditioned air
- Supplies nitrogen enriched air (NEA) to the center tank
- Does a check of system performance.

The Nitrogen Generation System has these subsystems:

- Thermal control unit (TCU)
- Nitrogen generation
- Distribution
- Control
- Indication

The TCU has components in the left ECS compartment and in the left ram air duct compartment.

The nitrogen generation components are in the left ram air duct compartment.

The nitrogen enriched air distribution system (NEADS) has components in the left ram air duct compartment, in the center tank, in the right surge tank, and in the left wheel well.

The NGS controller is installed aft of the forward cargo area.

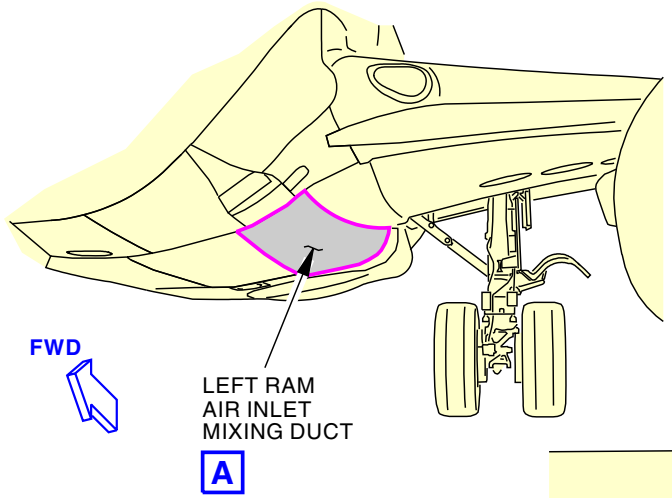
The BITE display unit is in the right ECS compartment.

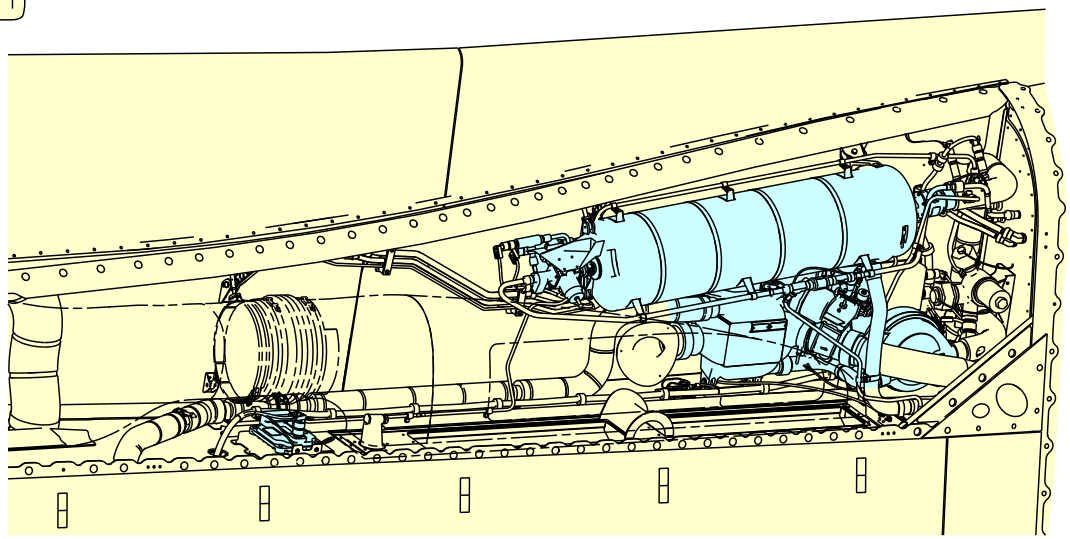
The operability indicator is in the right wheel well, adjacent to the P28 APU Remote Control Panel.

Abbreviations and Acronyms

- ASM - air separation module
- BDU - BITE display unit
- BITE - Built-In-Test equipment
- GSE - ground support equipment
- NEA - nitrogen enriched air
- NEADS - nitrogen enriched air distribution system
- NGS - nitrogen generation system
- PRSOV - pressure regulating and shutoff valve
- OEA - oxygen enriched air
- OTSOV - overtemperature shutoff valve
- RAV - ram air valve
- TCU - thermal control unit

NITROGEN GENERATION SYSTEM - INTRODUCTION





LEFT RAM AIR INLET MIXING DUCT
(VIEW IN THE INBOARD DIRECTION)

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NITROGEN GENERATION SYSTEM

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NITROGEN GENERATION SYSTEM - FUNCTIONAL DESCRIPTION

General

The Nitrogen Generation System (NGS) uses bleed air from the left pneumatic manifold. To control the bleed air pressure, the NGS shutoff valve is installed next to the pneumatic manifold. The NGS controller directly controls the NGS shutoff valve.

Operation

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

Bleed air goes through the ozone converter to change the ozone in the air to oxygen. Ozone can decrease the performance and mechanical properties of the Air Separation Module (ASM).

The heat exchanger uses ram air to decrease the bleed air temperature to 160 ±10°F (71 ±6°C). The ram air valve adjusts the quantity of cool air that goes through the heat exchanger. The temperature sensor sends temperature data to the NGS controller. The NGS controller adjusts the ram air valve.

The NGS filter removes contamination before the air goes into the ASM. A differential pressure sensor monitors the NGS filter.

The ASM decreases the oxygen in the air below the quantity necessary to support combustion. The ASM is designed to remove 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 into the center tank. The NGS controller uses data from the altitude sensor, high flow valve differential pressure sensor, and airplane systems to open or close the high flow valve.

The Nitrogen-Enriched Air Distribution System (NEADS) sends NEA to the center tank. NEA goes into the fuel tank through an ejector nozzle in the climb vent in the left part of the center tank. A float valve in the right part of the center 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 while the aircraft descends.

The NGS controller monitors and controls system operating temperatures and pressures.

An operability indicator gives a visual indication of the system condition.

You use the BITE Display Unit (BDU) to test the NGS system.

You can use the Ground Support Equipment (GSE) O_2 test port or BDU to test the oxygen percentage downstream of the ASM.

After the takeoff and during the climb, the system operates first in the low-flow mode. The system goes to the high-flow mode when the NGS controller senses an altitude of 15,000 feet.

The NGS is in the high-flow mode for 10 minutes or until it is in the cruise mode. This is to increase the temperature of the system before the O_2 sensor Built-In-Test (BIT). This lets the ASM become stable before the test starts.

After the test, the NGS controller gives 10 minutes for the system to get and record O_2 data. The NGS controller compares O_2 levels with maximum satisfactory performance tables installed into the NGS controller software. If O_2 indications are higher than maximum satisfactory levels, the test is a failure and the NGS controller records the data.

NOTE: If the flight is lower than 15,000 feet, the test occurs during the descent.

NOTE: Before the airplane hits cruise altitude, if the test is not completed, the test occurs during the descent.

The NGS operates in the low-flow mode during cruise flight. The high-flow valve is closed. NEA goes to the center fuel tank from the ASM through the low-flow orifice. The NGS uses the low-flow mode during cruise flight to decrease the requirements of bleed air.

NITROGEN GENERATION SYSTEM - FUNCTIONAL DESCRIPTION

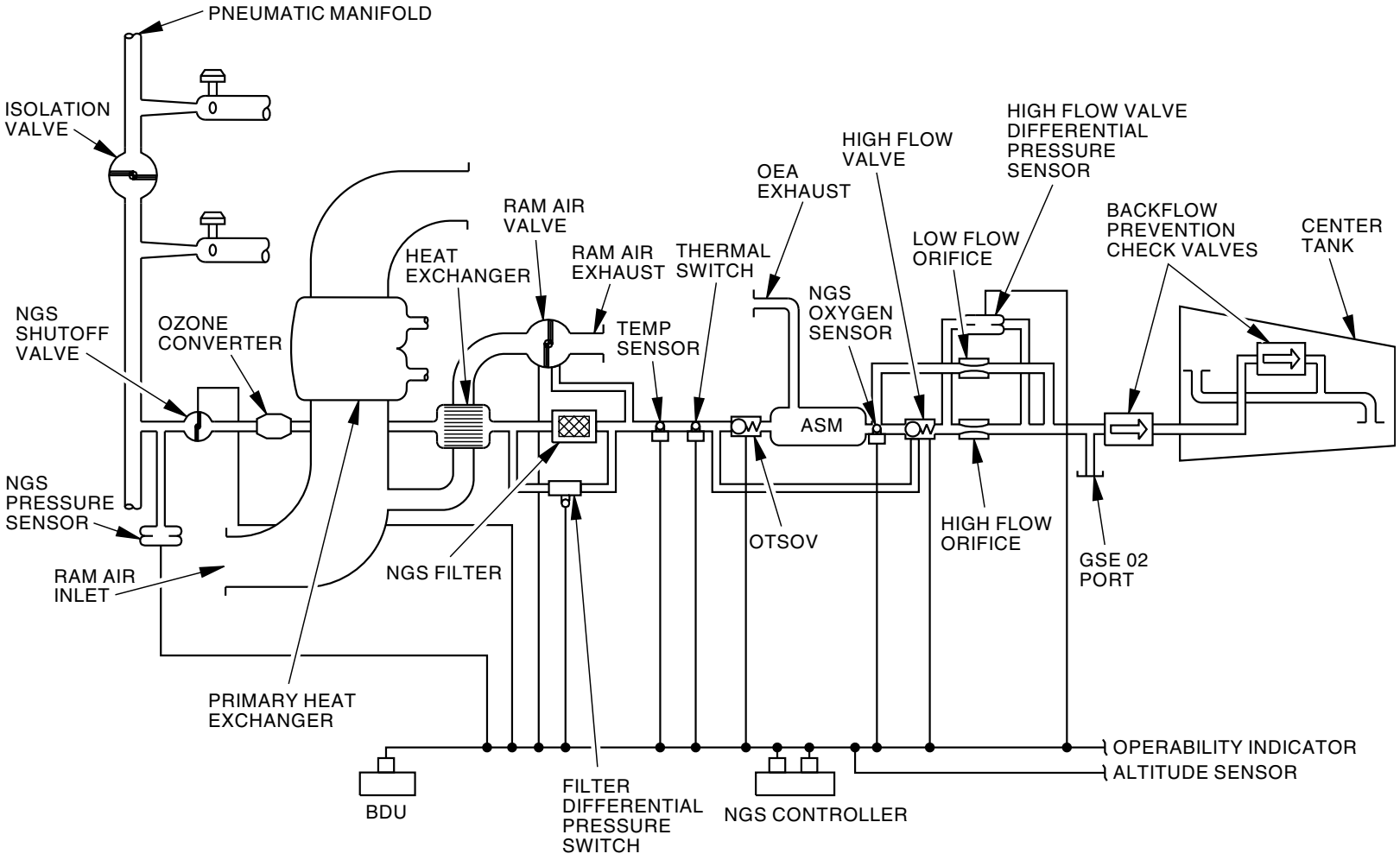
The NGS operates in the high-flow mode during the descent to pressurize the center fuel tank with NEA. The NGS high-flow valve opens by a signal from the NGS controller. NEA goes through the high-flow and low-flow orifices to pressurize the center fuel tank.

When the airplane lands, the NGS changes from the high-flow mode to the low-flow mode. The NGS operates in the low-flow mode on the ground for 10 minutes. When the left Flow Control and Shutoff Valve (FCSOV) closes before 10 minutes, the NGS does not start again when the FCSOV opens. When the airplane completes 10 minutes, the system goes to the cooldown mode. There is no flow through the system during the cooldown mode.

The NGS cooldown mode prevents damage to the NGS heat exchanger. Ram air flow will not go to the heat exchanger. This prevents a thermal shock from a fast cooldown. The NGS cooldown mode keeps the NGS Shutoff Valve (SOV) open and closes the Over Temperature Shutoff Valve (OTSOV). This lets system pressure go to the Ram Air Valve (RAV) to keep the valve closed. There is no ram air flow at this time.

After the NGS cooldown mode of 30 minutes stops, the NGS SOV closes. The RAV goes from full closed to full open.

NITROGEN GENERATION SYSTEM - FUNCTIONAL DESCRIPTION



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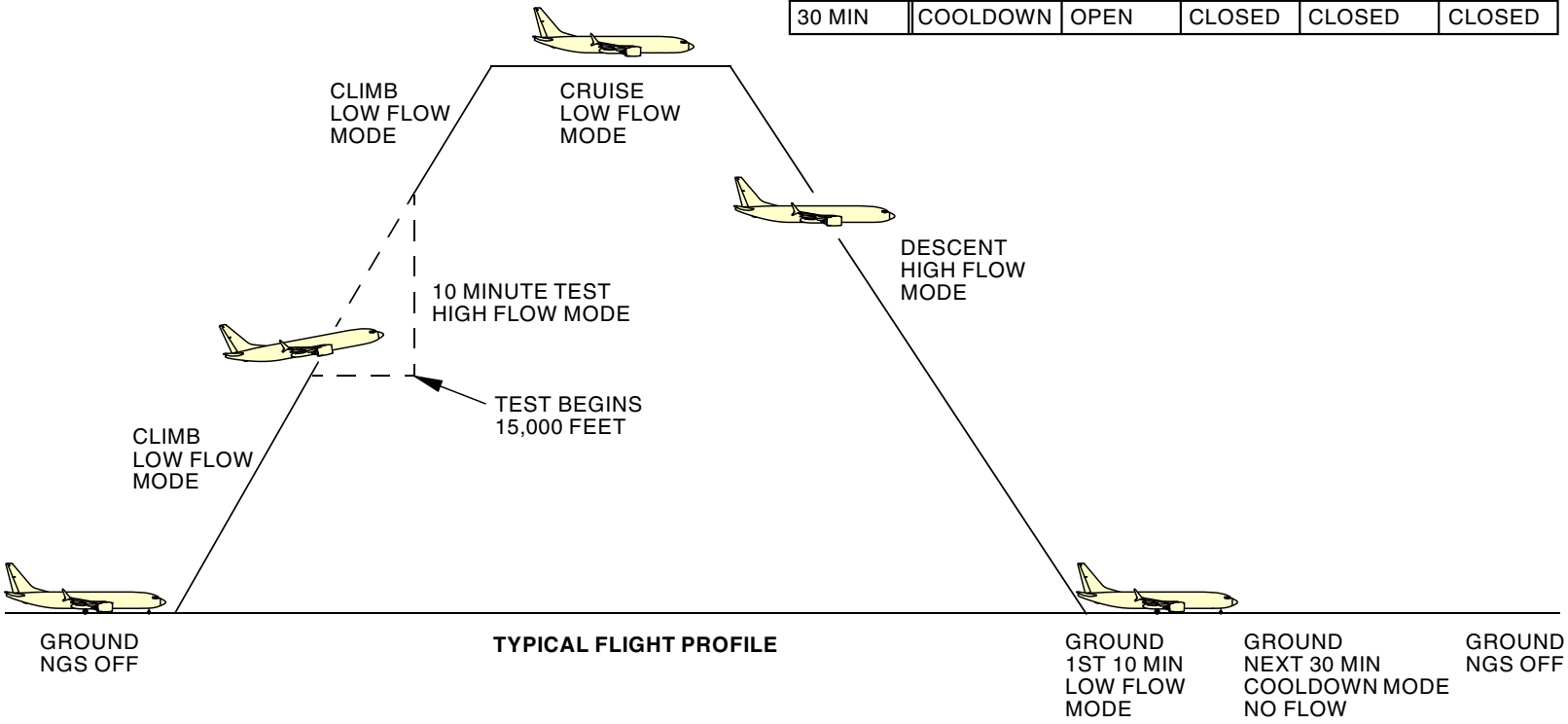
NITROGEN GENERATION SYSTEM - GENERAL DESCRIPTION

NITROGEN GENERATION SYSTEM - FUNCTIONAL DESCRIPTION

	MODE	SOV	OTV	RAV	HFV
GROUND	NGS OFF	CLOSED	CLOSED	OPEN	CLOSED
CLIMB	LOW	OPEN	OPEN	MODULATE	CLOSED
TEST	HIGH	OPEN	OPEN	MODULATE	OPEN
CRUISE	LOW	OPEN	OPEN	MODULATE	CLOSED
DESCENT	HIGH	OPEN	OPEN	MODULATE	OPEN
10 MIN	LOW	OPEN	OPEN	MODULATE	CLOSED
30 MIN	COOLDOWN	OPEN	CLOSED	CLOSED	CLOSED



NITROGEN GENERATION SYSTEM - OPERATION

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NITROGEN GENERATION SYSTEM - OPERATION

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NITROGEN GENERATION SYSTEM - COMPONENT LOCATION - 1

Thermal Control Unit (TCU) - Left Air Conditioning Bay

These TCU components are located in the forward-left side air conditioning bay:

- NGS pressure sensor
- NGS shutoff valve
- Ozone converter.

Thermal Control Unit (TCU) - Left Ram Air Inlet Mixing Duct Bay

These TCU components are located in the left ram-air duct bay. They are outboard of the left air conditioning compartment:

- Heat exchanger
- Ram air valve
- NGS filter
- Filter differential pressure switch
- Thermal switch
- Temperature sensor

Nitrogen Generation System (NGS) - Left Ram Air Inlet Mixing Duct Bay

These NGS components are in the left ram air inlet mixing duct bay:

- NGS Oxygen Sensor
- High Flow Orifice
- Altitude sensor
- Air Separation Unit (ASU). The ASU consists of the following:
  - Air Separation Module (ASM)
  - High Flow Valve (HFV)
  - Over Temperature Shutoff Valve (OTSOV)
  - HFV Differential Pressure Sensor.

Bite Display Unit (BDU)

The BITE display unit is on the right 41 beam adjacent to the forward wall of the air conditioning compartment. You can access it through the right air conditioning bay door.

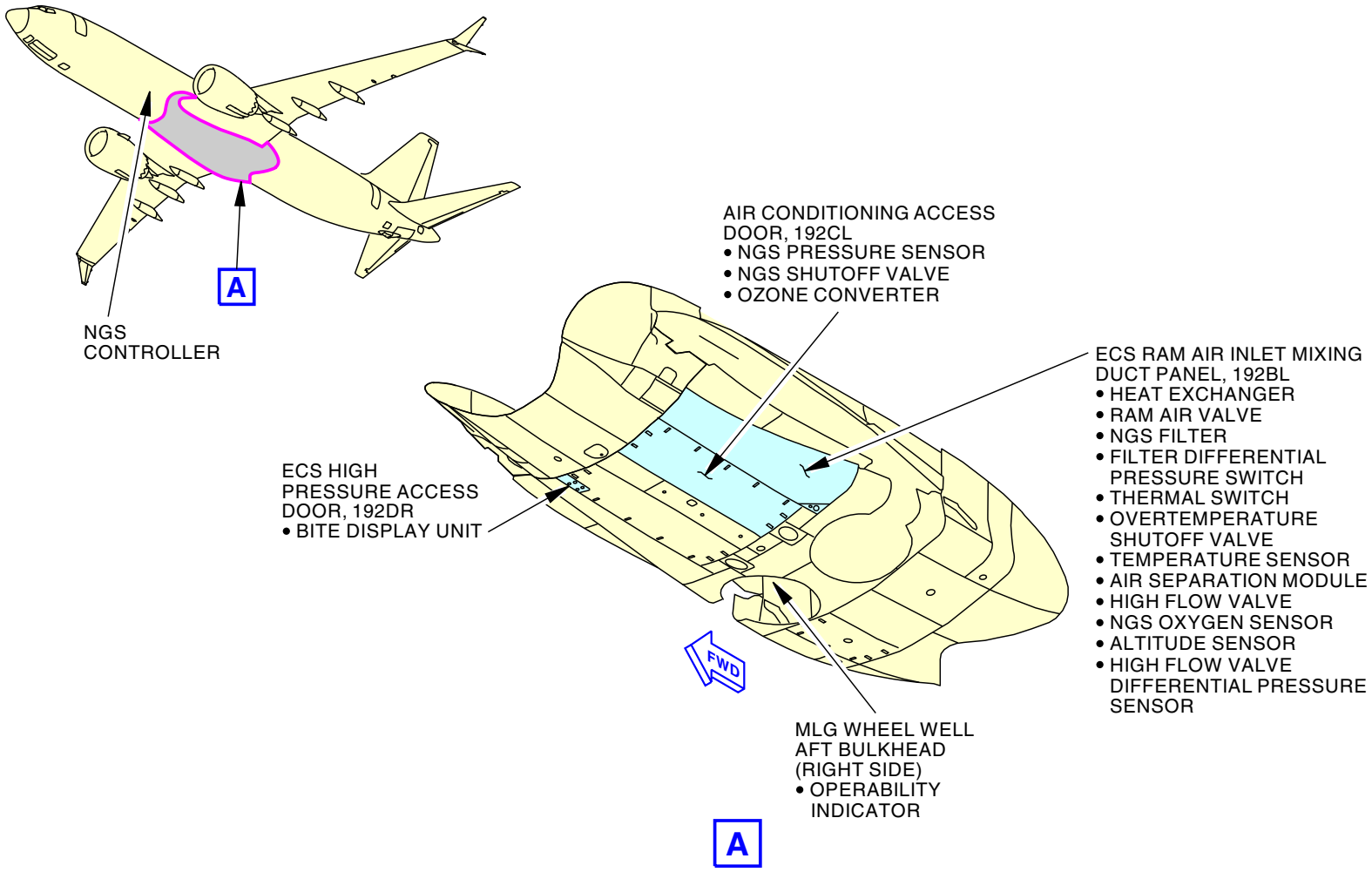
Operability Indicator

The NGS operability indicator is on the aft bulkhead in the right wheel well, adjacent to the APU fire control panel.

NGS Control System

The NGS controller is in the pressurized mix bay aft of the forward cargo compartment.

NITROGEN GENERATION SYSTEM - COMPONENT LOCATION - 1



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NITROGEN GENERATION SYSTEM - COMPONENT LOCATION - 1

NITROGEN GENERATION SYSTEM - COMPONENT LOCATION - 2

Nitrogen Enriched Air Distribution System (NEADS) - Center Tank

These NEADS components are in the center tank:

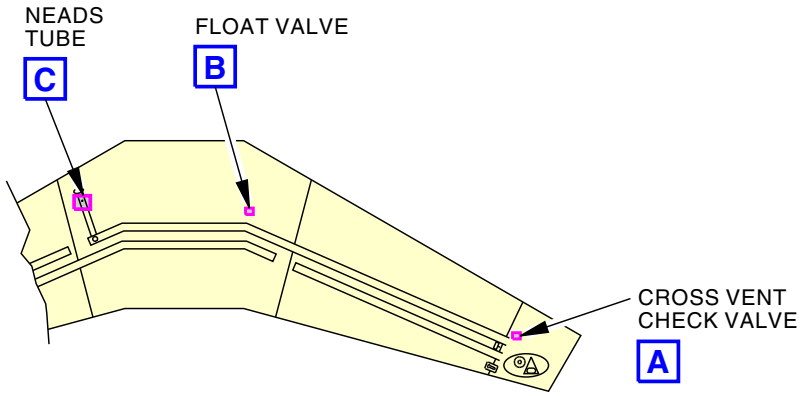
- Primary backflow prevention check valve
- Ejector nozzle
- Float valve.

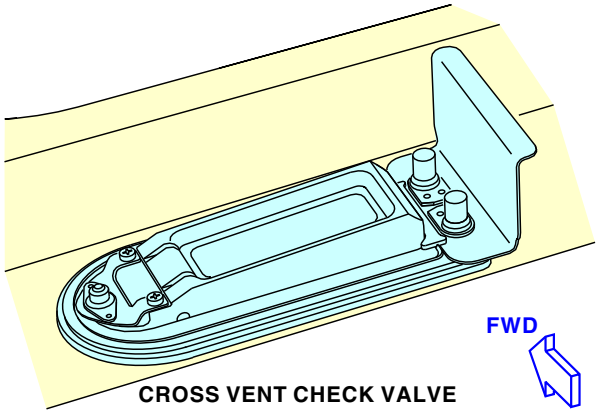
Nitrogen Enriched Air Distribution System (NEADS) - Surge Tank

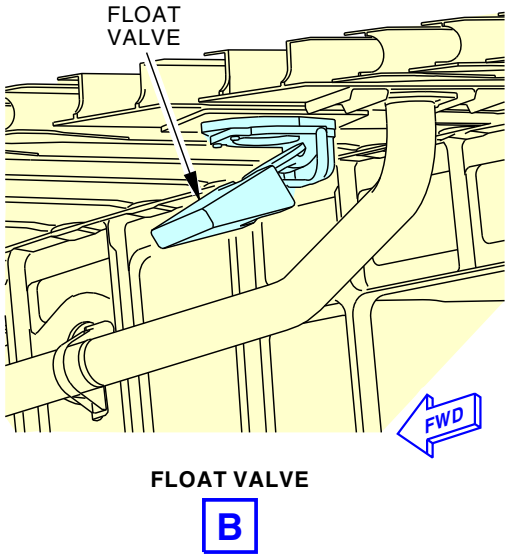
This NEADS component is in the surge tank:

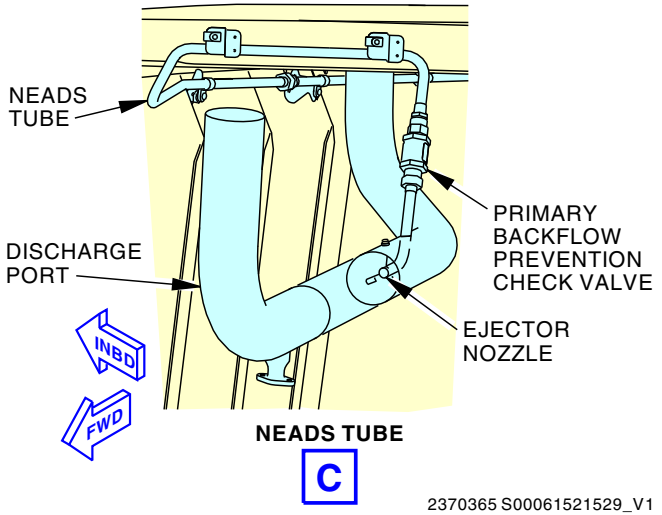
- Cross vent check valve.

NITROGEN GENERATION SYSTEM - COMPONENT LOCATION - 2









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NITROGEN GENERATION SYSTEM - COMPONENT LOCATION - 2

NITROGEN GENERATION SYSTEM - COMPONENT LOCATION - 3

Nitrogen Enriched Air Distribution System (NEADS) - Ram Air Inlet Mixing Duct

These NEADS components are in the left ram air inlet mixing duct compartment:

- Secondary backflow prevention check valve
- Drain cap
- GSE O_2 test port.

Nitrogen Enriched Air Distribution System (NEADS) - Left Wheel Well

This NEADS component is in the left wheel well:

- Flame arrestor

SIA 015-999; SIA 001-014 POST SB 737-47-1019

- Drain cap.

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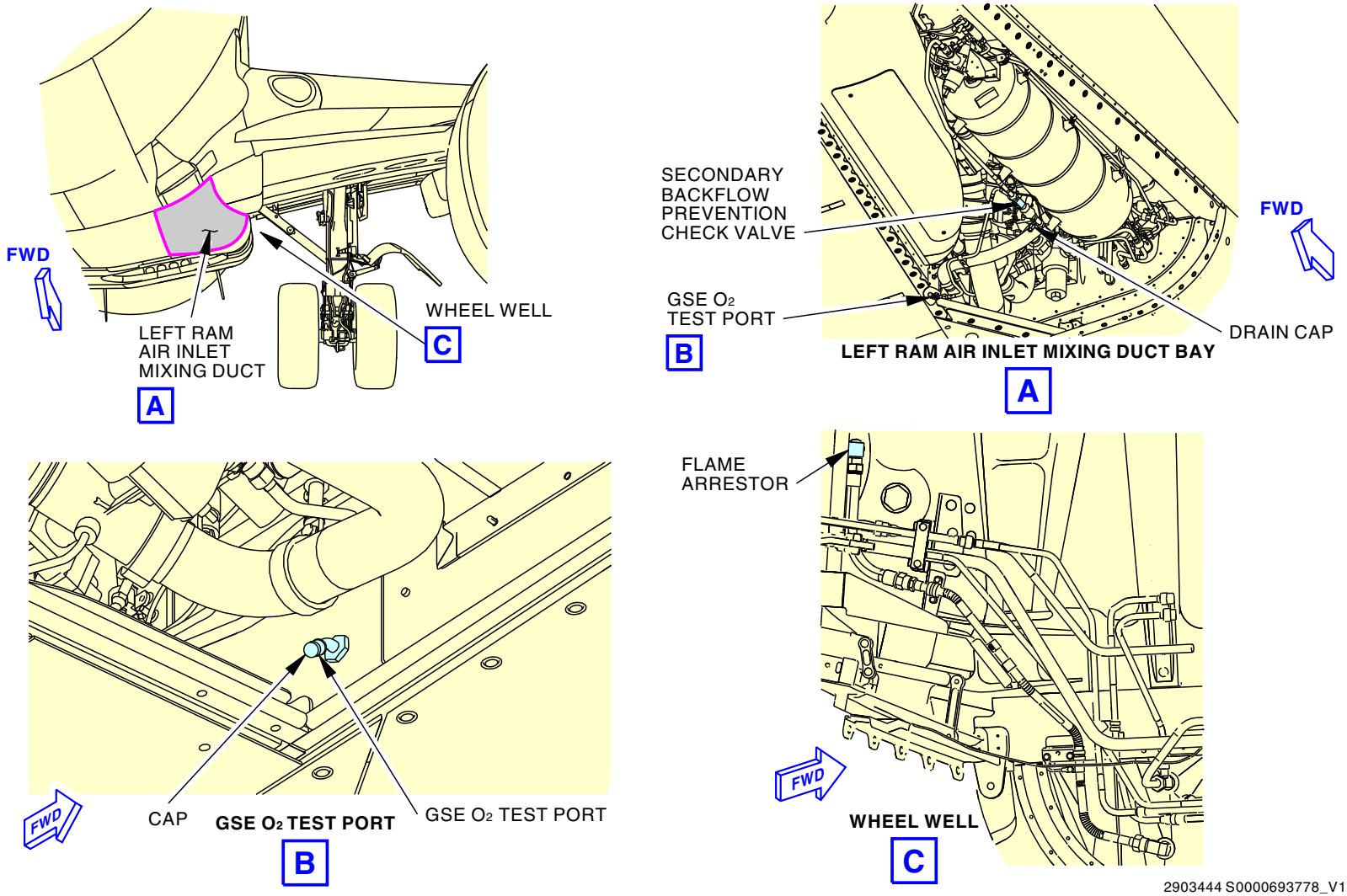
NITROGEN GENERATION SYSTEM - COMPONENT LOCATION - 3



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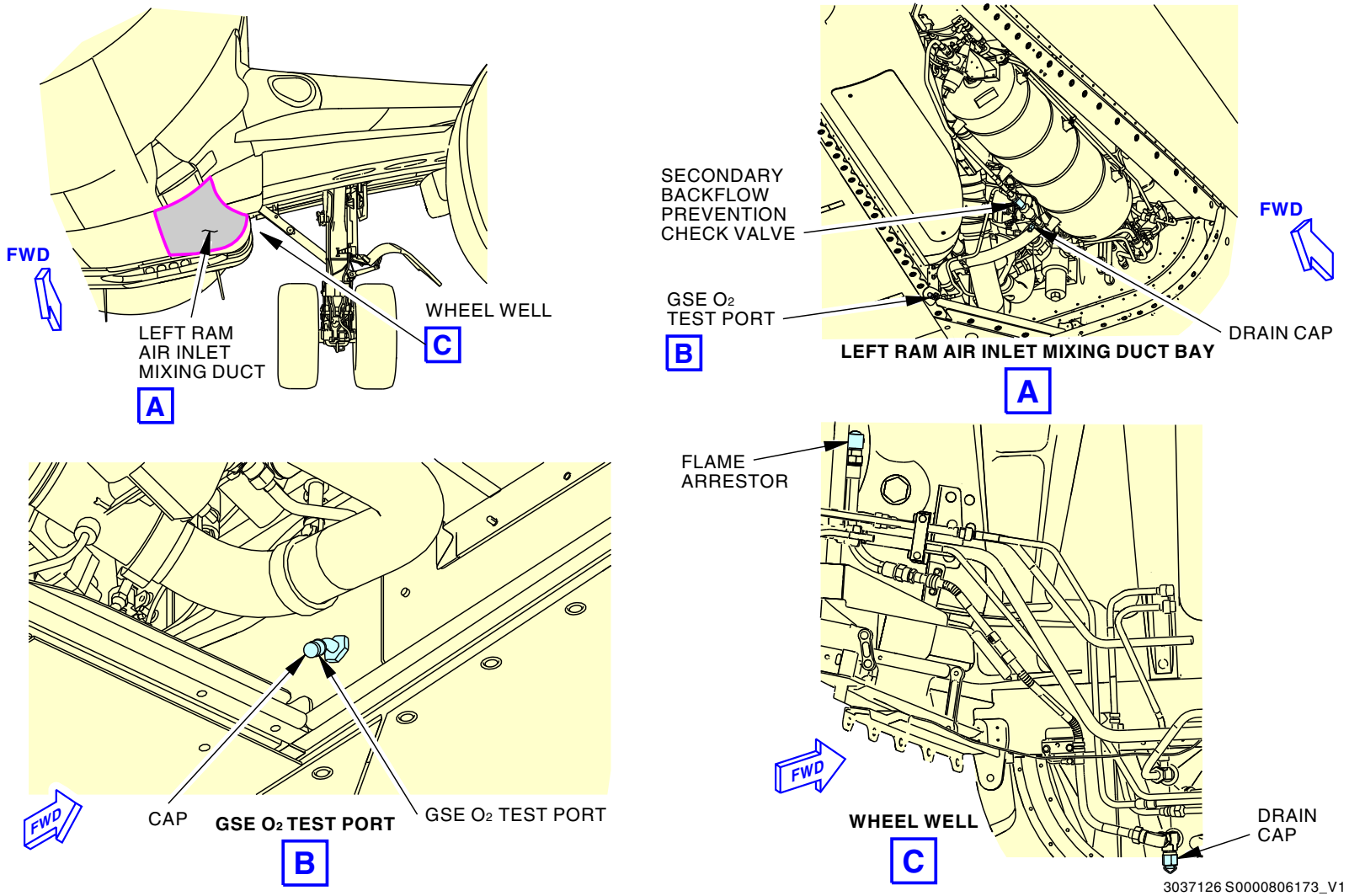
NGS - COMPONENT LOCATION - 3

NITROGEN GENERATION SYSTEM - COMPONENT LOCATION - 3



NGS - COMPONENT LOCATION - 3

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THERMAL CONTROL UNIT - INTRODUCTION

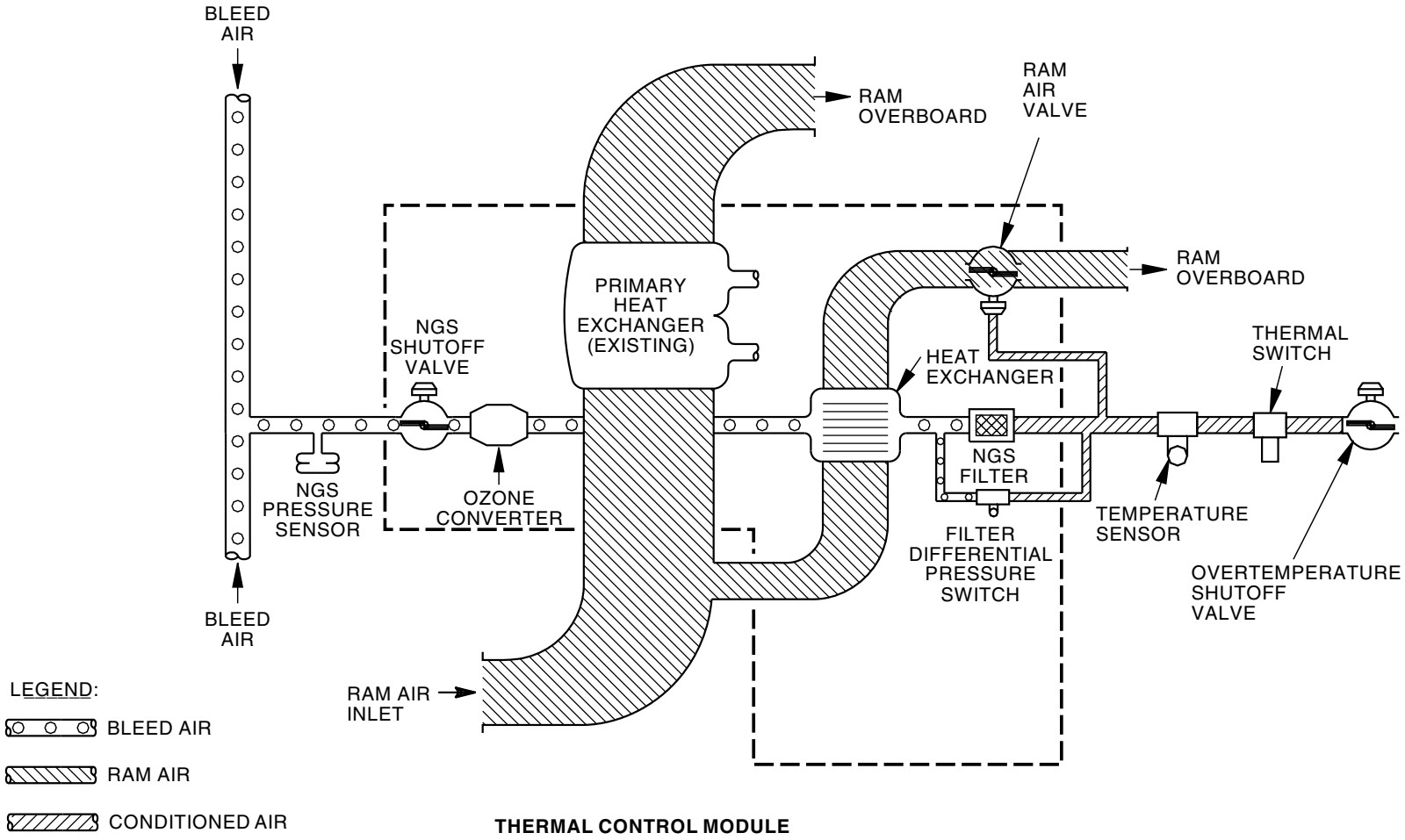
General

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

These are the components of the TCU:

- NGS Pressure Sensor
- NGS shutoff valve
- Ozone converter
- Heat exchanger
- Ram air valve
- NGS Filter
- Filter differential pressure switch
- Temperature sensor
- Thermal switch
- Overtemperature Shutoff Valve (OTSOV).

THERMAL CONTROL UNIT - INTRODUCTION



THERMAL CONTROL MODULE

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THERMAL CONTROL UNIT

NGS PRESSURE SENSOR

Purpose

The NGS pressure sensor monitors the bleed air pressure that goes into the nitrogen generation system (NGS).

Location

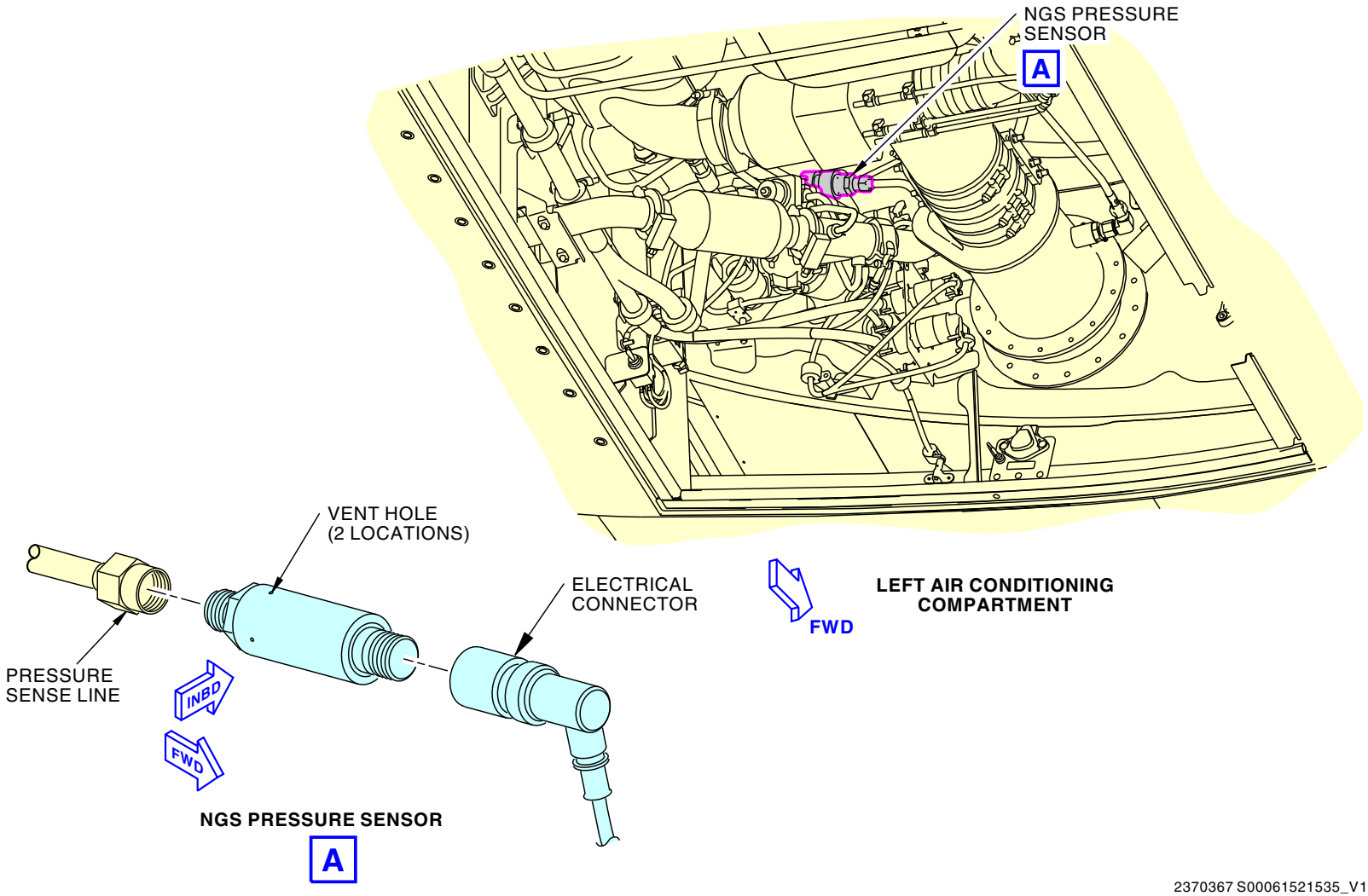
The NGS pressure sensor is on the forward bulkhead of the left air conditioning compartment.

General Description

The NGS pressure sensor has an airtight sealed electronic circuitry housed in a corrosion-resistant steel shell. Bleed air comes from the pressure sense line and goes into the sensor. The NGS controller supplies power to the NGS pressure sensor to monitor the bleed air pressure that goes into the NGS system.

When the bleed air pressure goes more than 67 psig (462 kPa), the NGS controller is notified. The NGS controller then commands the NGS shutoff valve and the over-temperature shutoff valve (OTSOV) to close. This prevents damage to the air separation module (ASM) and the center tank.

NGS PRESSURE SENSOR



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NGS PRESSURE SENSOR

NGS SHUTOFF VALVE - INTRODUCTION

Purpose

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

Location

The NGS shutoff valve is in the forward section of the left air conditioning compartment.

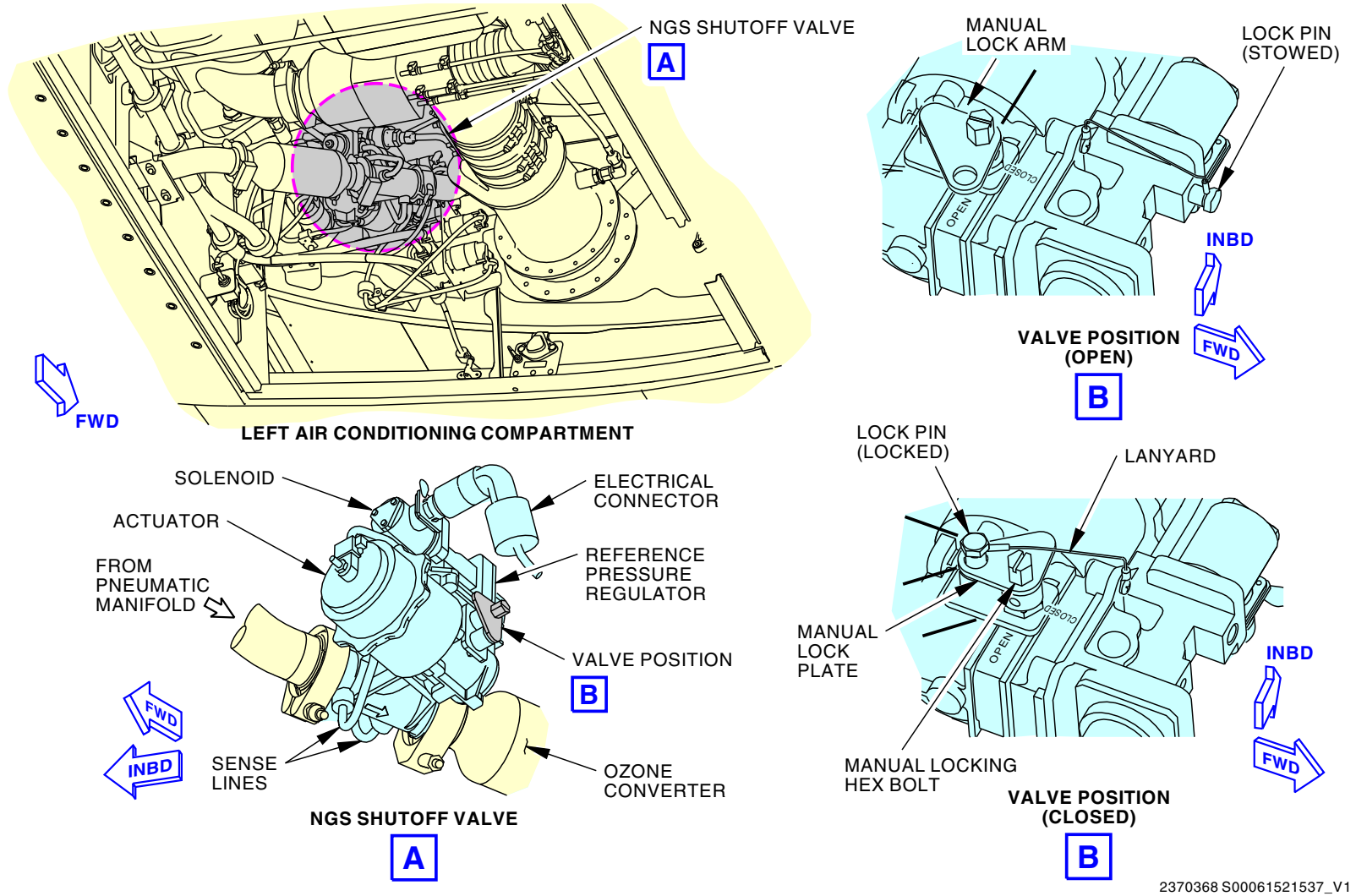
Physical Description

The NGS shutoff valve is an electrically commanded, pneumatically actuated pressure regulating and shutoff valve. A reference pressure regulator establishes a constant gauge pressure. The butterfly closure element is spring-loaded closed. A double acting, dual area, diaphragm-piston actuator positions the butterfly by comparing reference pressure to the downstream bleed air pressure admitted through a downstream sense tube. The solenoid controls the shutoff. The NGS shutoff valve includes a manual override.

These are the parts of the NGS shutoff valve:

- Solenoid
- Electrical connector
- Sense lines
- Reference pressure regulator
- Actuator
- Manual override and position indicator
- Manual lock arm
- Lock pin (attached to a lanyard).

NGS SHUTOFF VALVE - INTRODUCTION



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NGS SHUTOFF VALVE - INTRODUCTION

NGS SHUTOFF VALVE - FUNCTIONAL DESCRIPTION

Functional Description

The NGS receives bleed air from the pneumatic manifold. The bleed air travels through the NGS shutoff valve, into reference pressure regulator. The reference pressure regulator controls the valve operating pressure to 10 psig (69 kPa). This reference pressure then flows to the solenoid, which then flows to the opening chamber or is vented.

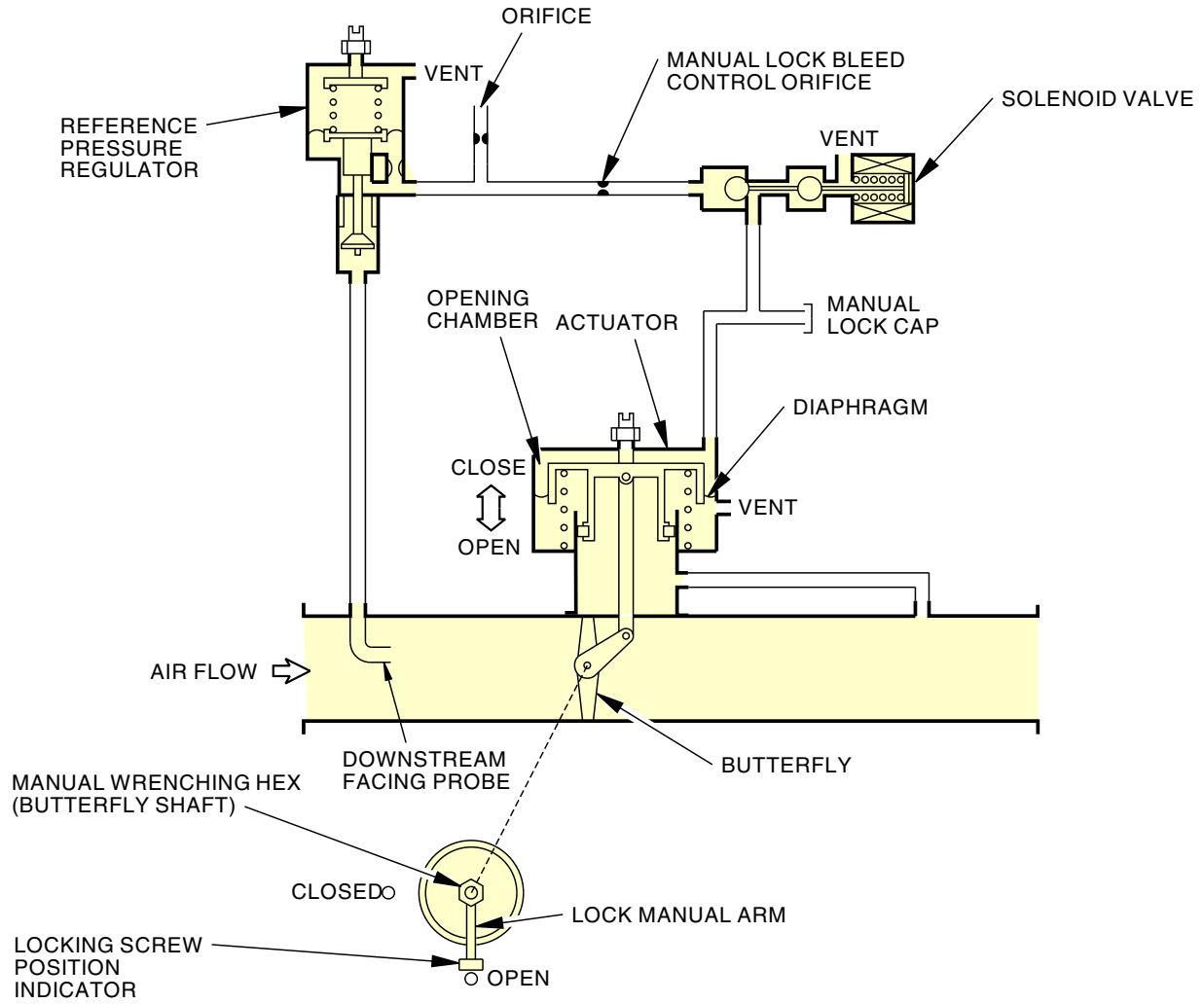
When the controller sends a signal to close the NGS shutoff valve, the solenoid is de-energized, which closes the butterfly valve. The de-energized solenoid blocks the reference pressure to the opening chamber of the actuator. The existing pressure in the opening chamber is vented through the solenoid vent. With the reference pressure blocked to the opening chamber, the spring keeps the butterfly valve closed

When the controller sends a signal to open the butterfly valve, the NGS shutoff valve is energized. This supplies 28V DC power to the solenoid valve. The energized solenoid closes the solenoid vent and allows the reference pressure into the opening chamber of the actuator. The reference pressure acting on the diaphragm overcomes the spring force and causes the butterfly valve to turn to the open position.

When an over-temperature occurs in the NGS, the controller sends a command to close the NGS shutoff valve. This protects the sensitive equipment downstream from damage.

The manual override allows you to disable the NGS shutoff valve. To manually lock the valve, the manual lock cap is removed to vent the opening chamber. The butterfly valve is manually overridden and the cap is placed at the manual override location to lock the valve in the closed position only.

NGS SHUTOFF VALVE - FUNCTIONAL DESCRIPTION



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NGS SHUTOFF VALVE - FUNCTIONAL DESCRIPTION

OZONE CONVERTER

Purpose

The ozone converter decreases the ozone content in the bleed air by catalytic conversion to oxygen. The ozone converter prevents damage to the air separation module (ASM) from oxidation of the membrane material by ozone. This can cause a deterioration of the mechanical properties of the membrane.

This ozone converter protects the air separation module (ASM) from oxidation of the membrane materials by ozone.

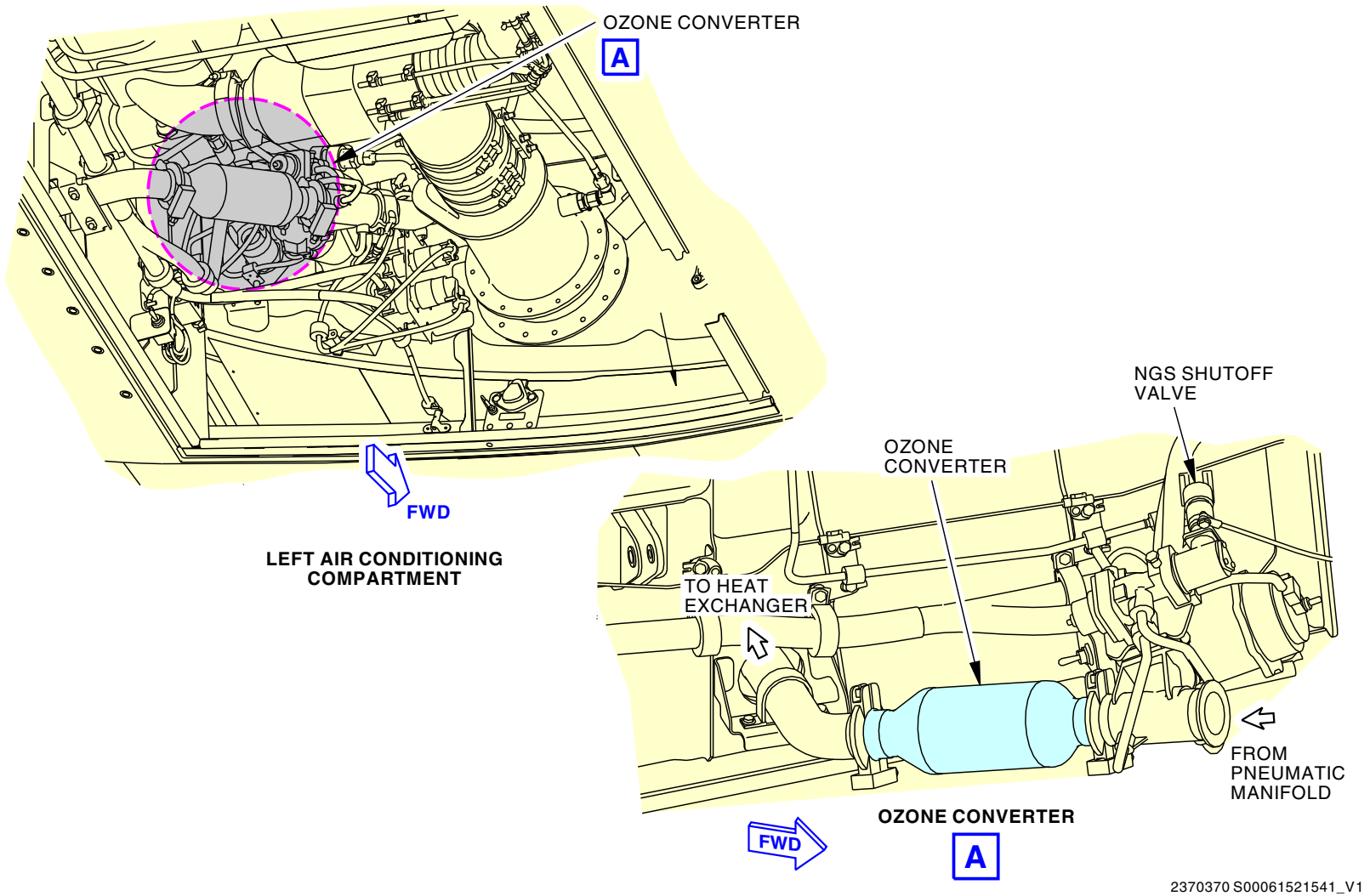
Location

The ozone converter is in the forward section of the left air conditioning compartment.

General Description

The ozone converter uses a stainless steel mantle shell. The catalytic reactor core features a straight-channel tin configuration to minimize pressure drop. Hot bleed air that contains ozone enters the ozone converter through the inlet. As the air comes in contact with the heated catalytic reactor core the ozone is converted to oxygen. The bleed air then exits the converter through the outlet.

OZONE CONVERTER



OZONE CONVERTER

EFFECTIVITY

SIA ALL

HEAT EXCHANGER

Purpose

The primary functions of the heat exchanger is to compress the bleed air and to condition the bleed air to 160.0 ±10.0°F (71.1 ±5.6°C) during normal operating conditions. Also, the heat exchanger prevents hot bleed air from going into the fuel tank, if a system double failure occurs.

Hot bleed air that goes through the heat exchanger is automatically conditioned by the ram air. The ram air valve controls the amount of ram air that goes through the heat exchanger. Conditioned air continues to the NGS filter.

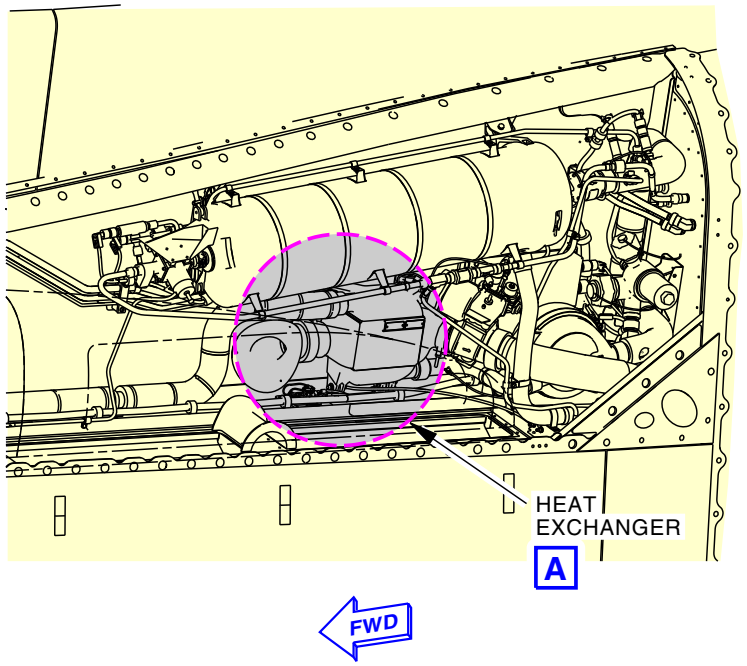
Location

The heat exchanger is in the left ram air duct compartment, inboard of the ASM.

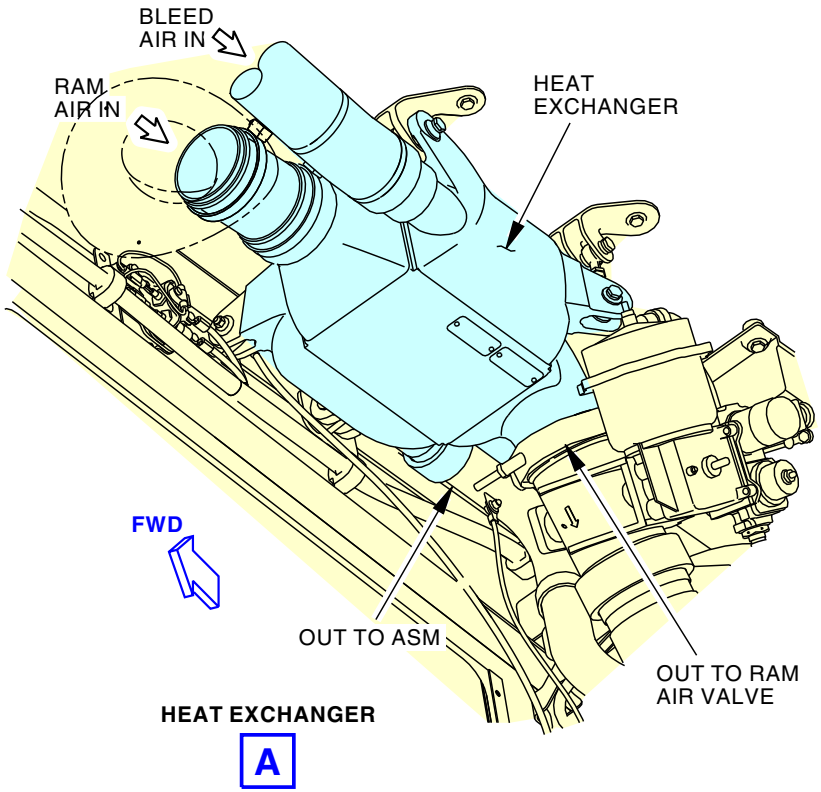
General Description

The heat exchanger is an aluminum plate-fin, single-pass, crossflow, air-to-air heat exchanger. Both bleed air and ram air fins are made from aluminum alloy sheet.

HEAT EXCHANGER



LEFT RAM AIR INLET MIXING DUCT



HEAT EXCHANGER

A

2370371 S00061521543_V1

HEAT EXCHANGER

RAM AIR VALVE - INTRODUCTION

Purpose

The ram air valve can control the ram air flow through the heat exchanger, from inputs from the NGS controller.

Location

The ram air valve is in the left ram air duct compartment behind the ram air access panel.

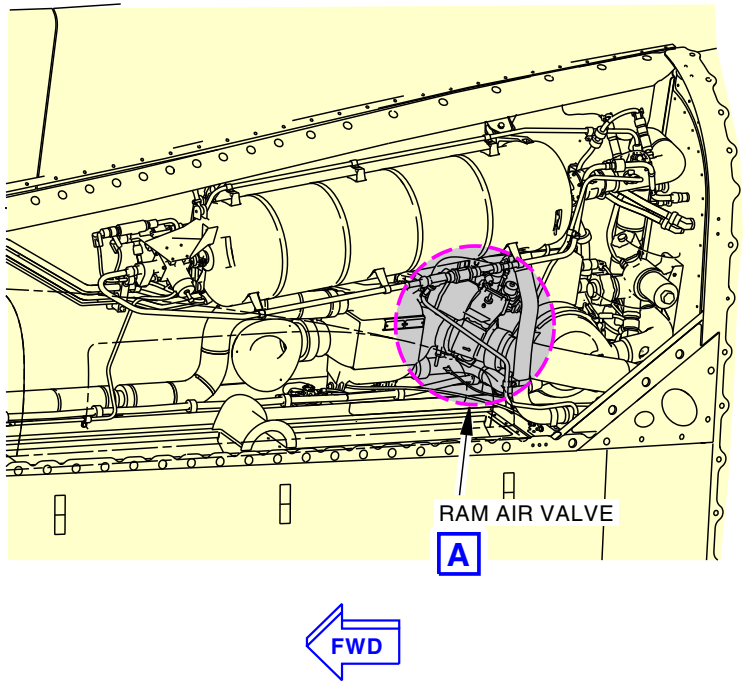
Physical Description

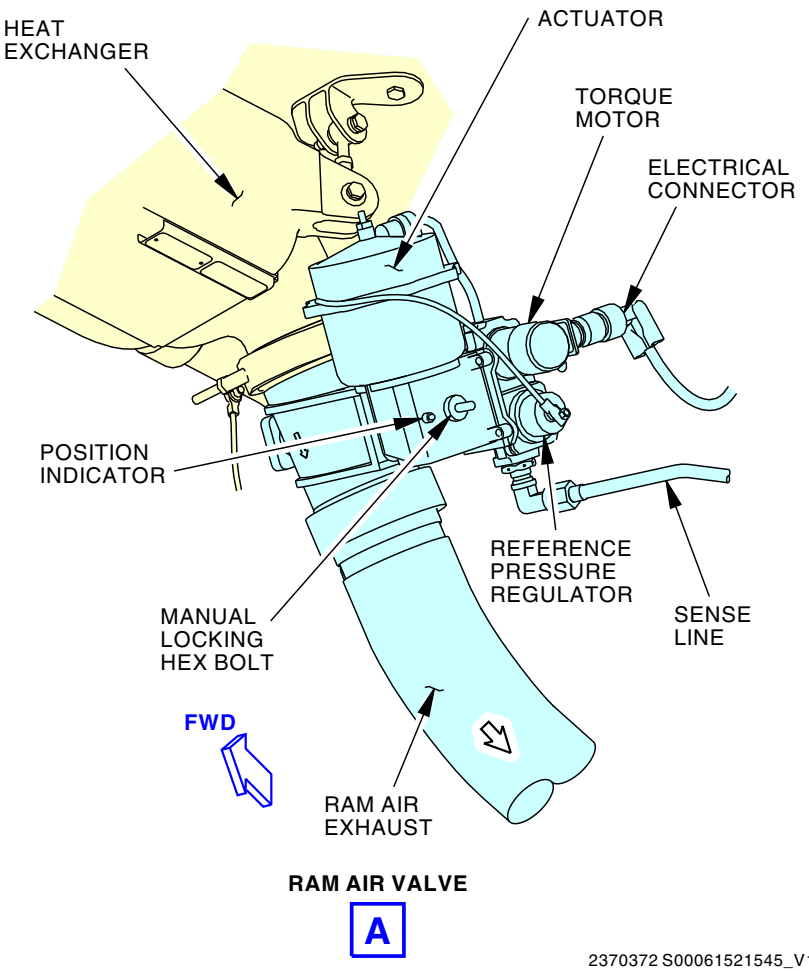
The ram air valve is electrically controlled and pneumatically actuated butterfly type valve that modulates airflow as a function of the torque motor. A remote temperature sensor and electronic controller give a signal to the valve torque motor to position the butterfly closure element. The valve has a visual position indicator and can be manually wrenched and locked in the open position.

These are the main components of the ram air valve:

- Torque motor
- Electrical connector
- Sense line
- Reference pressure regulator
- Actuator
- Position indicator
- Manual locking hex bolt.

RAM AIR VALVE - INTRODUCTION





2370372 S00061521545_V1

RAM AIR VALVE - INTRODUCTION

RAM AIR VALVE - FUNCTIONAL DESCRIPTION

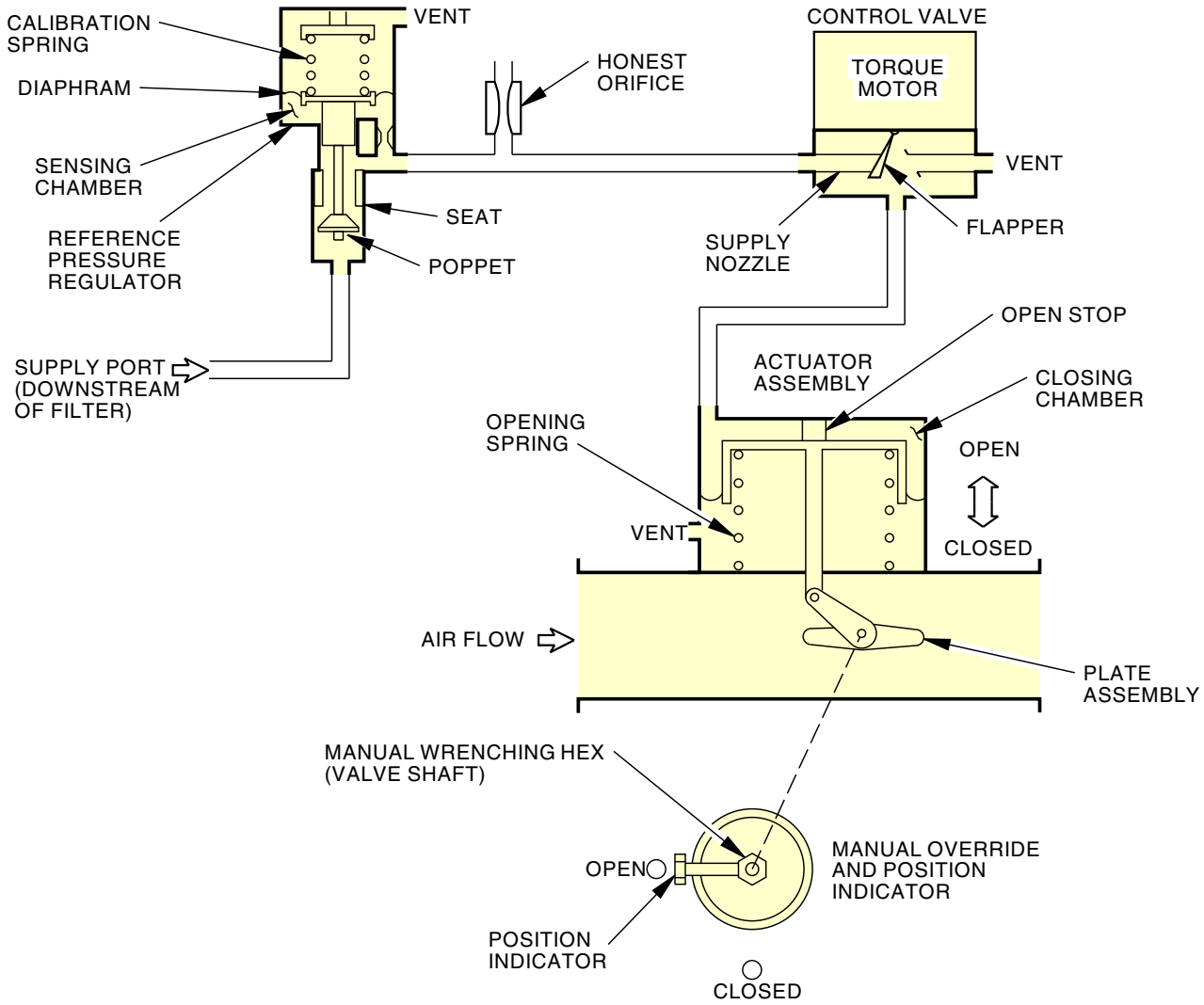
Functional Description

The ram air shutoff valve is a spring loaded open, pneumatically actuated, torque motor controlled butterfly modulating and shutoff valve. The torque motor controls the level at which the valve modulates ram airflow across the heat exchanger.

Remote supply pressure is ported to the reference regulator. Air flows past the poppet and seat of the regulator into the sensing chamber. When the pressure downstream of the reference regulator reaches the desired level, the force created by this pressure on the regulator diaphragm tends to close the regulator. This force overcomes the calibration spring force in the regulator, causing the poppet to stroke towards the seat until a force equilibrium is achieved. The regulator thus produces a regulated output pressure (reference pressure) which is independent of inlet pressure variations.

Zero electrical current applied to the torque motor results in the supply port being closed off from the control port. Also, no pressure is allowed into the actuator closing chamber and the butterfly element is in the full open position. As the electrical current to the torque motor is increased, the flapper moves to increase the supply area and reduce the vent area, thereby increasing pressure to the actuator-closing chamber to move the butterfly element to the closed position. As torque motor current is decreased the flapper moves to decrease the supply area and increase the vent area, thereby reducing pressure to the actuator closing chamber to move the butterfly element to the open position.

RAM AIR VALVE - FUNCTIONAL DESCRIPTION



2370373 S00061521547_V1

RAM AIR VALVE - FUNCTIONAL DESCRIPTION

NGS FILTER

Purpose

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

Location

The air filter is in the left ram air duct compartment behind the ram air duct access panel.

Functional Description

The NGS air filter assembly has two stages. There is an inner pleated coalescer filter pack and downstream, an outer high efficiency pleated filter pack.

The coalescer stage has 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 to remove large drops (example: water and hydrocarbon fuels). This layer uses a repulsion coalescence mechanism coupled with a wicking action to give high efficient coalescence. Unwanted fluids are drained through the secondary port.

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.

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

The pleated filter packs are held by perforated stainless steel and aluminum shrouds, and found in aluminum end caps. The filter medias and support cores are potted into the end caps with an epoxy resin compound.

The integrated element assembly, which incorporates 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 insulation features.

The filter assembly also includes an insulation jacket that prevents damage to the bowl. This jacket is manufactured from polyimide foam and wire locked 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.

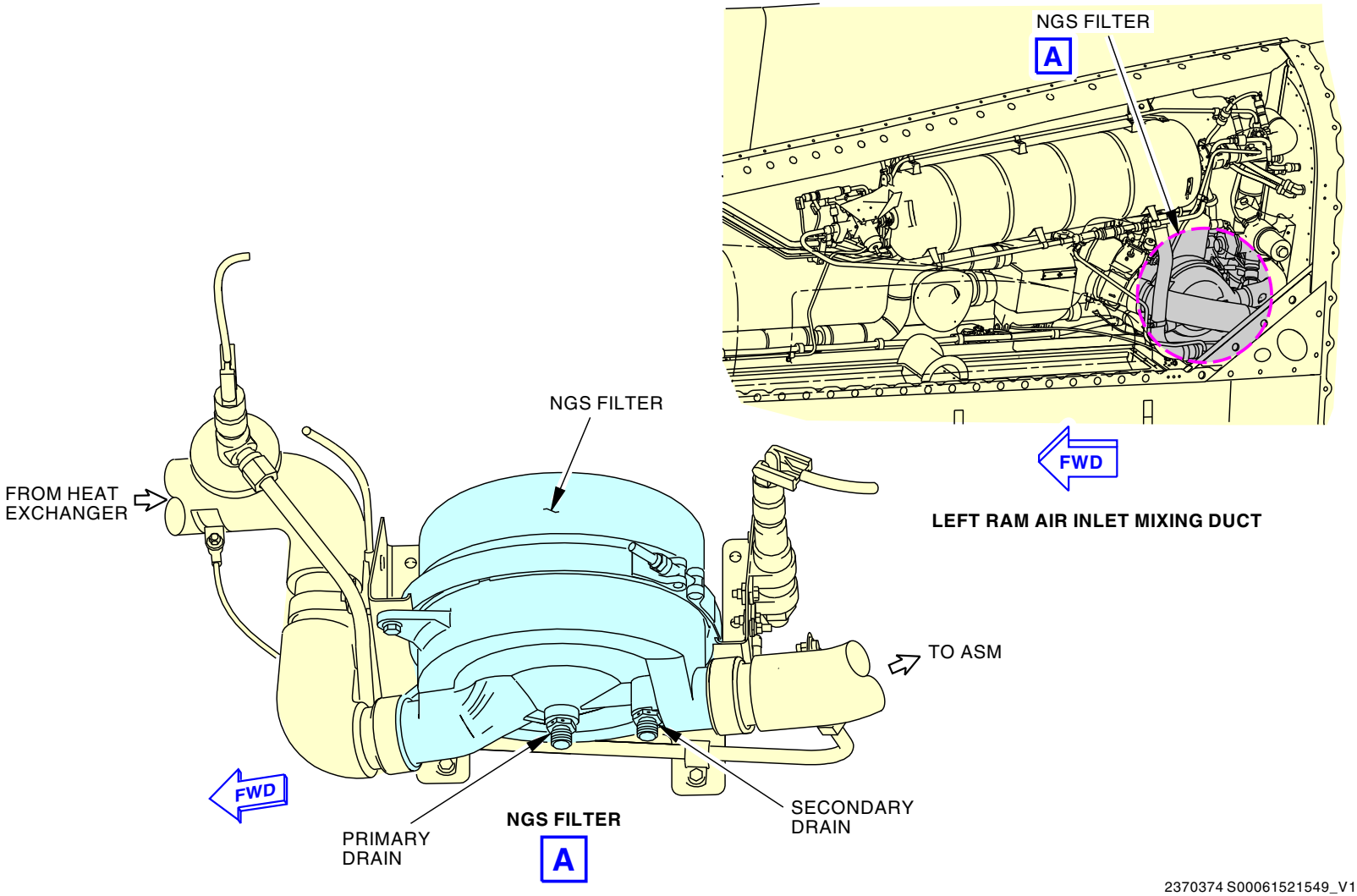
SIA 015-999; SIA 001-014 POST SB 737-47-1016

Ozone Removal Description

An ozone removal step is included into the particulate filter because of the ASM ozone sensitivity. The catalyst in the filter is optimized for ozone removal efficiency at lower temperature. It also has the particulate element of the filter to filter most of the contamination from the bleed air. This ozone/particulate filter with the upstream ozone converter helps keep the systems ASM performance.

SIA ALL

NGS FILTER



AIR FILTER

FILTER DIFFERENTIAL PRESSURE SWITCH

Purpose

The filter differential pressure switch senses when to replace the NGS filter.

Location

The filter differential pressure switch is in the left ram air duct compartment behind the ram air duct access panel.

Physical Description

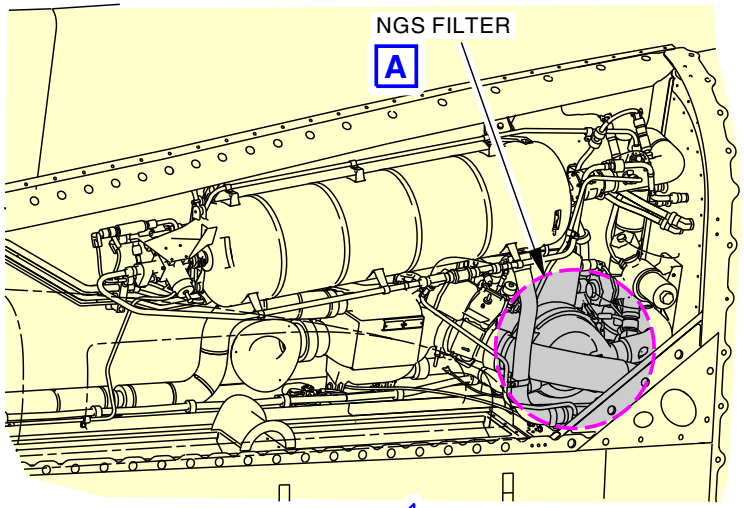
The pressure switch is a snap action, diaphragm type switch with an electrical connector. This is attached directly to the inlet air duct for the NGS filter. A sense line from the outlet air duct of the NGS filter supplies feedback on the NGS filter operating condition.

Functional Description

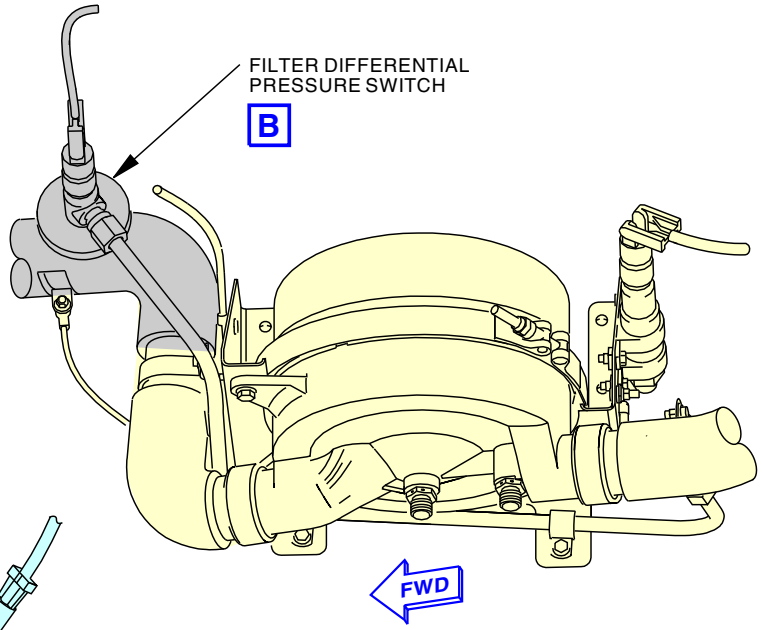
The filter differential pressure switch closes when a pressure drop of 1.2 ±0.1 psid (8.3 ±0.7 kPa) is detected. This sends a fault signal to the NGS controller that the NGS filter must be cleaned or replaced.

When the pressure difference decreases to 0.3 psid (2.1 kPa), the pressure switch opens.

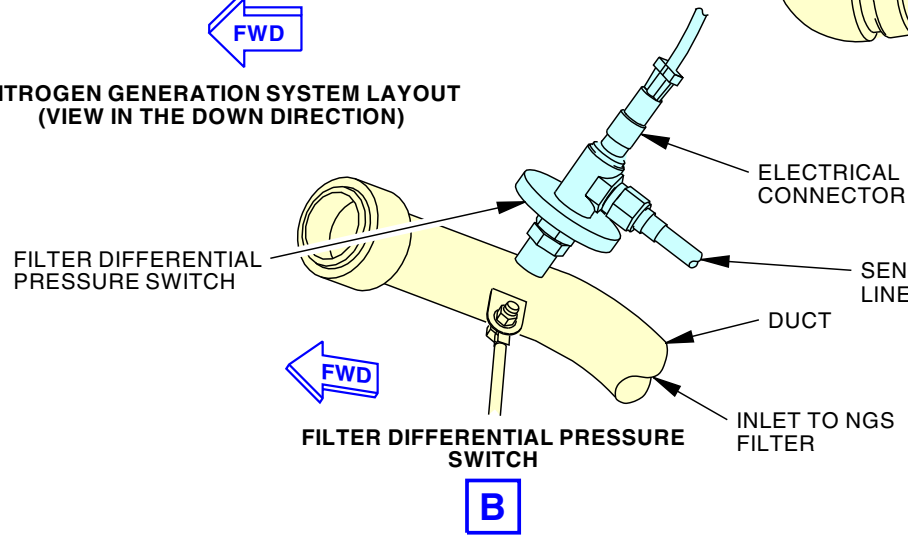
FILTER DIFFERENTIAL PRESSURE SWITCH



NITROGEN GENERATION SYSTEM LAYOUT
(VIEW IN THE DOWN DIRECTION)



NGS FILTER
A



FILTER DIFFERENTIAL PRESSURE
SWITCH
B

2370375 S00061521551_V1

FILTER DIFFERENTIAL PRESSURE SWITCH

TEMPERATURE SENSOR

Purpose

The temperature sensor measures the conditioned air temperature from the heat exchanger.

Location

The temperature sensor is installed in the left ram air duct compartment behind the ram air duct access panel. The temperature sensor is attached to the inlet duct, upstream of the Air Separation Module (ASM).

Physical Description

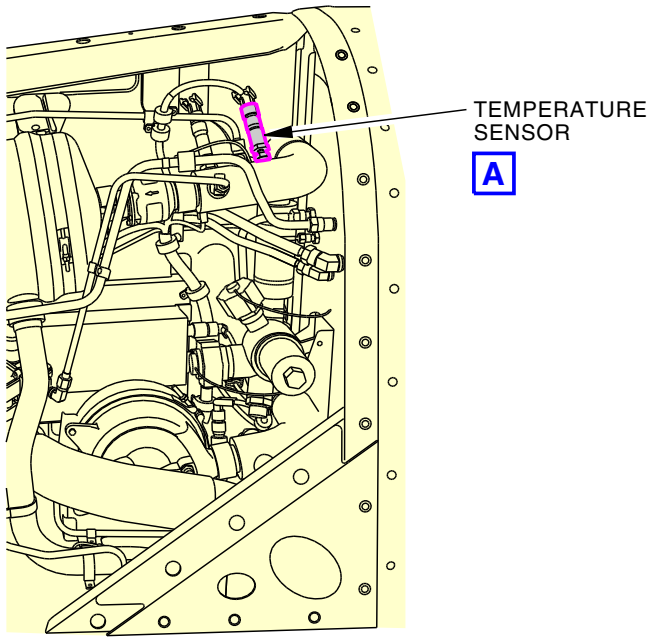
The temperature sensor is a hermetically sealed unit with dual sensor detectors housed in a corrosion-resistance stainless steel probe.

Functional Description

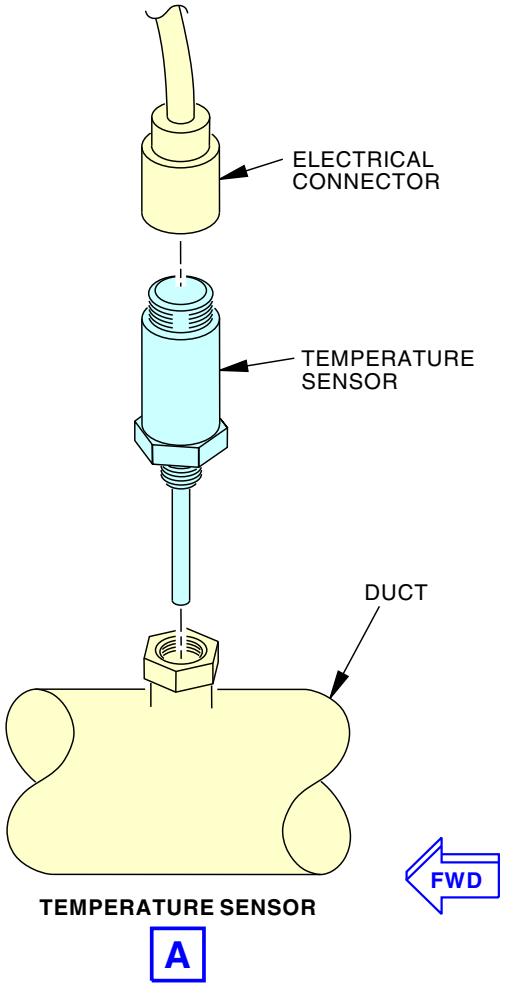
The temperature sensor measures the conditioned air temperature from the heat exchanger. The NGS controller processes the temperature data and regulates the ram air shutoff valve. This keeps a nominal air temperature of 160 ±10°F (71 ±6°C).

When the nominal temperature is more than 225 ±10°F (107 ±6°C), the NGS automatically closes the NGS shutoff valve and overtemperature shutoff valve to prevent heat damage to the ASM.

TEMPERATURE SENSOR



LEFT RAM AIR INLET MIXING DUCT



TEMPERATURE SENSOR

2370376 S00061521553_V2

TEMPERATURE SENSOR

THERMAL SWITCH

Purpose

The thermal switch is an auxiliary device that prevents an over-temperature condition to the air separation module (ASM).

Location

The thermal switch is in the left ram air duct compartment behind the ram air duct access panel. It is adjacent to the temperature sensor, upstream of the air separation module.

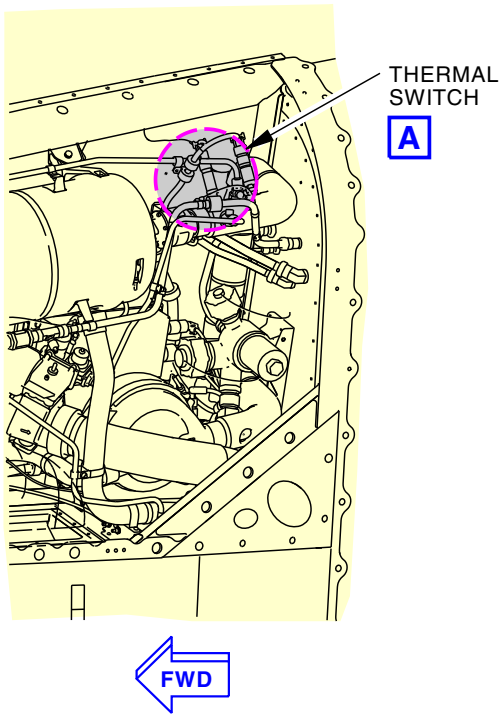
Physical Description

The thermal switch has a probe body, electrical connector, and is sealed in a metal housing.

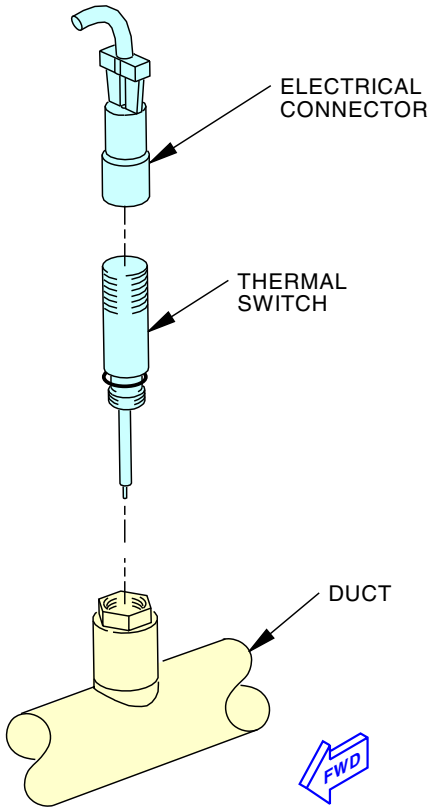
Functional Description

The thermal switch is a temperature sensitive device that is normally closed and opens when the sensed temperature in the ducts is more than 270 ±10°F (132 ±6°C). When activated, the thermal switch controls the overtemperature shutoff valve to the closed position. The deactivation of the thermal switch occurs when the temperature decreases below a 15°F (-9.4°C) minimum deadband.

THERMAL SWITCH



LEFT RAM AIR INLET MIXING DUCT



THERMAL SWITCH

A

2370377 S00061521555_V1

OVERTEMPERATURE SHUTOFF VALVE - INTRODUCTION

Purpose

The overtemperature shutoff valve (OTSOV) supplies protection to the air separation module and the center tank from high-temperature conditions.

Location

The OTSOV is in the left ram air duct compartment behind the ram air duct access panel.

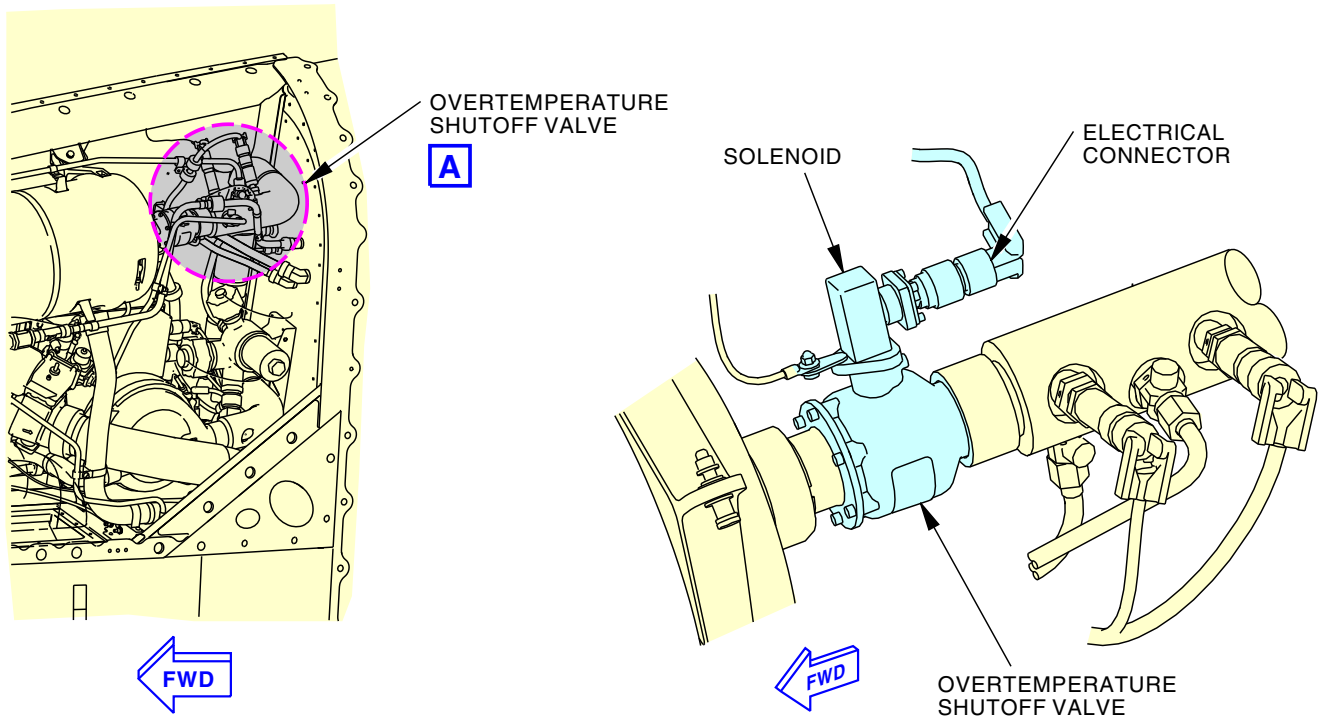
Physical Description

The OTSOV is an in-line, solenoid operated, shutoff valve. The shutoff valve stays closed until the solenoid valve assembly starts. The unit will fail in the closed position or close on loss of electrical power from the temperature switch that is found upstream of the valve.

The OTSOV is also a low leakage device to stop the tank from spilling during ground operation.

The OTSOV stays closed when de-energized, and holds its position with a spring and air pressure. The OTSOV opens when the solenoid energizes. The OTSOV will close when the temperature switch, found upstream of the OTSOV, goes more than 270.0°F (132.2°C). The NGS controller controls the OTSOV during the NGS system startup and system shutdown.

OVERTEMPERATURE SHUTOFF VALVE - INTRODUCTION



OVERTEMPERATURE SHUTOFF VALVE

A

2370378 S00061521557_V1

OVERTEMPERATURE SHUTOFF VALVE - INTRODUCTION

OVERTEMPERATURE SHUTOFF VALVE - FUNCTIONAL DESCRIPTION

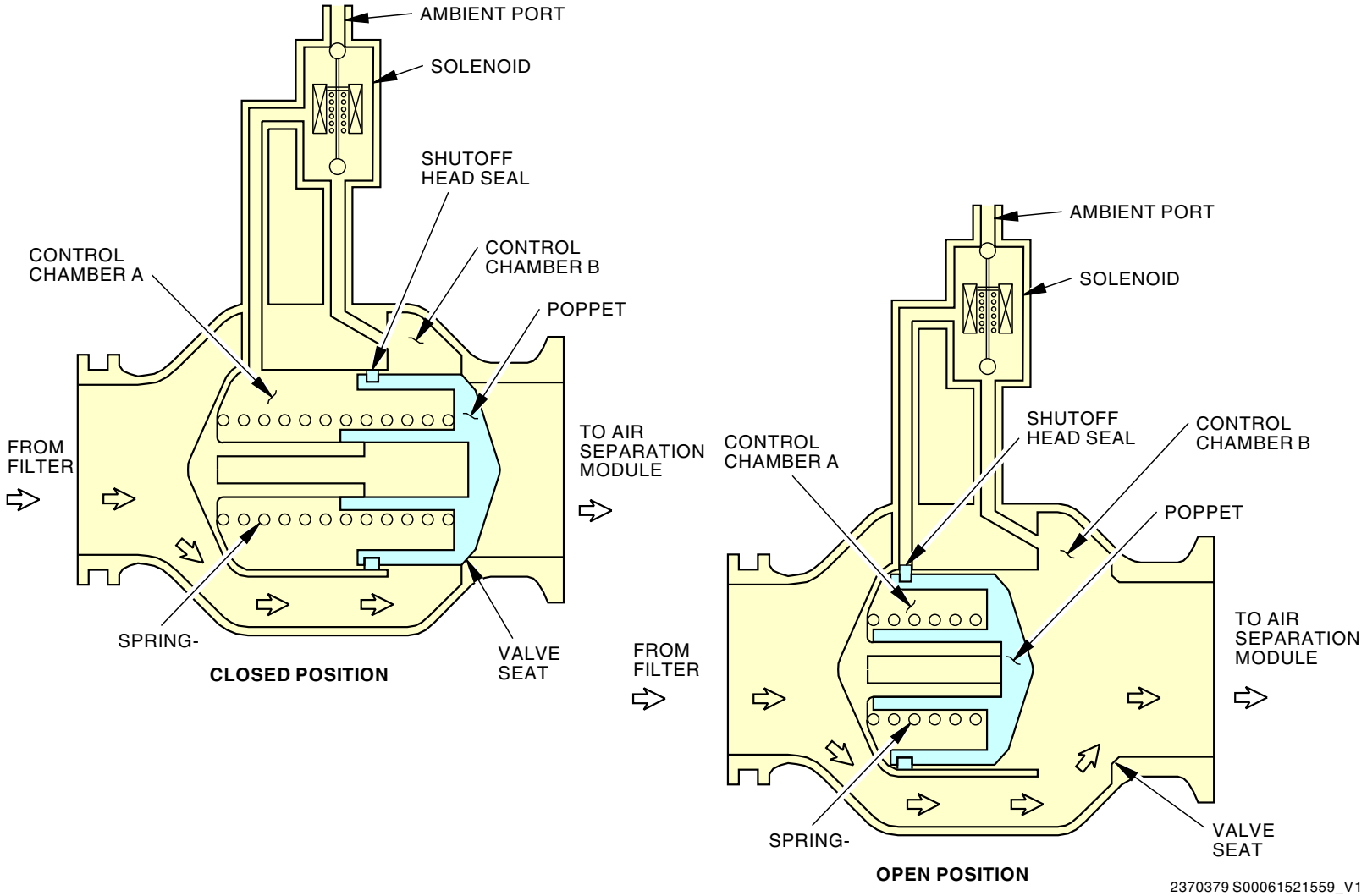
Functional Description

The overtemperature shutoff valve (OTSOV) is an in-line, solenoid operated, shutoff valve, electrically controlled and operated by differential pressure. The shutoff valve stays closed until the solenoid energizes. The unit will fail in the closed position or close on loss of electrical power from the temperature switch.

When the solenoid de-energizes, the ambient port is blocked. The air pressure in control chambers A and B are equal and the spring keeps the poppet closed.

When the solenoid energizes, control chamber A is open to ambient air pressure. The air pressure in control chamber B pushes on the poppet surfaces. The air pressure is more than the spring force and the valve opens slowly. The air pressure continues to push on a larger surface area, and moves the valve to the full open position.

OVERTEMPERATURE SHUTOFF VALVE - FUNCTIONAL DESCRIPTION



OVERTEMPERATURE SHUTOFF VALVE - FUNCTIONAL DESCRIPTION

AIR SEPARATION MODULE - INTRODUCTION

Purpose

The Air Separation Module (ASM) decreases the oxygen (O_2) concentration and increases the nitrogen concentration from the supplied conditioned air. The Nitrogen Enriched Air Distribution System (NEADS) supplies the nitrogen enriched air (NEA) to the center tank. Unwanted oxygen (O_2) is released overboard.

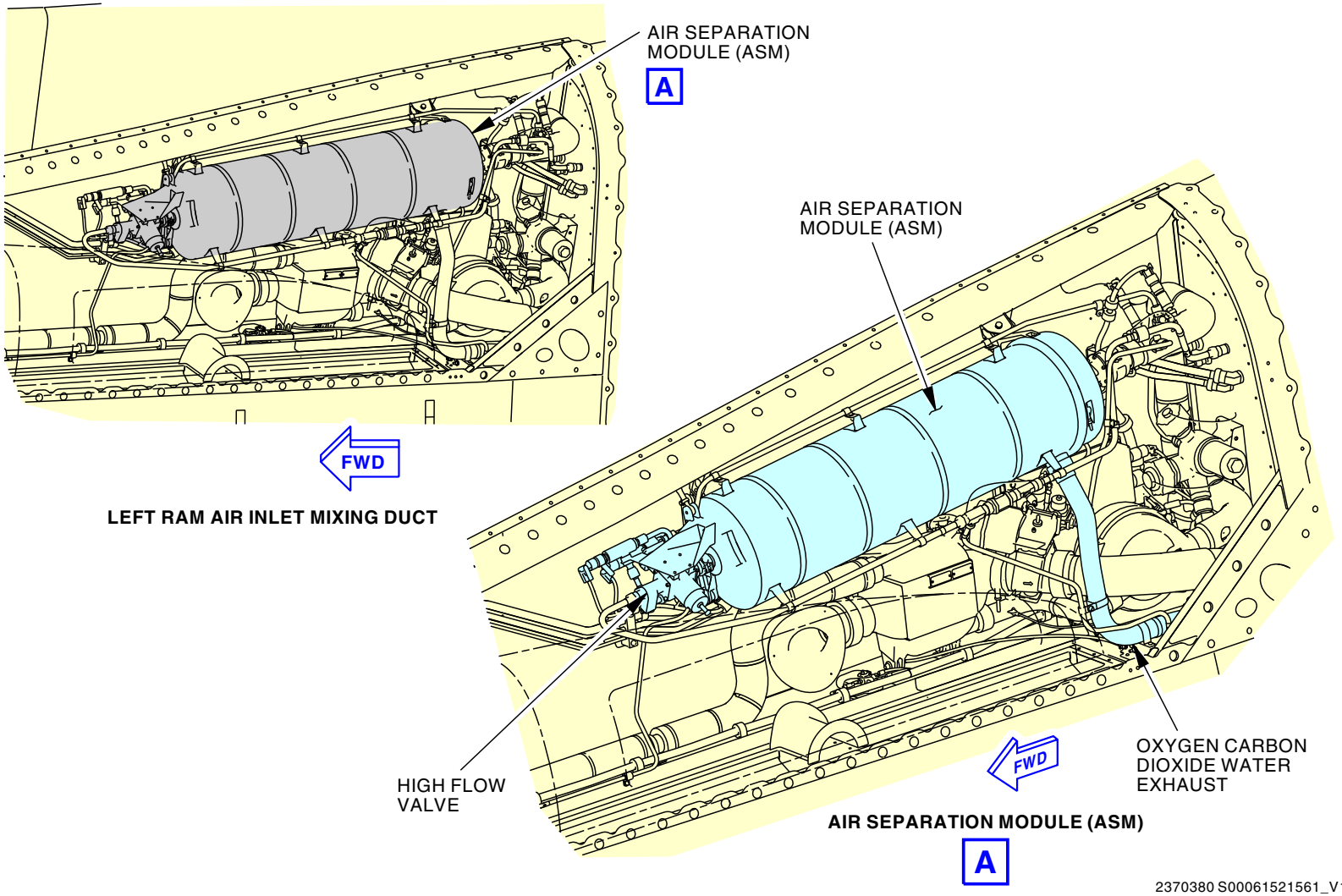
Location

The ASM is in the left ram air duct compartment behind the ram air duct access panel.

Physical Description

The ASM has a permeable fiber membrane bundle, contained in an aluminum housing. The ASM has a layer of insulation foam protection to prevent overheating.

AIR SEPARATION MODULE - INTRODUCTION



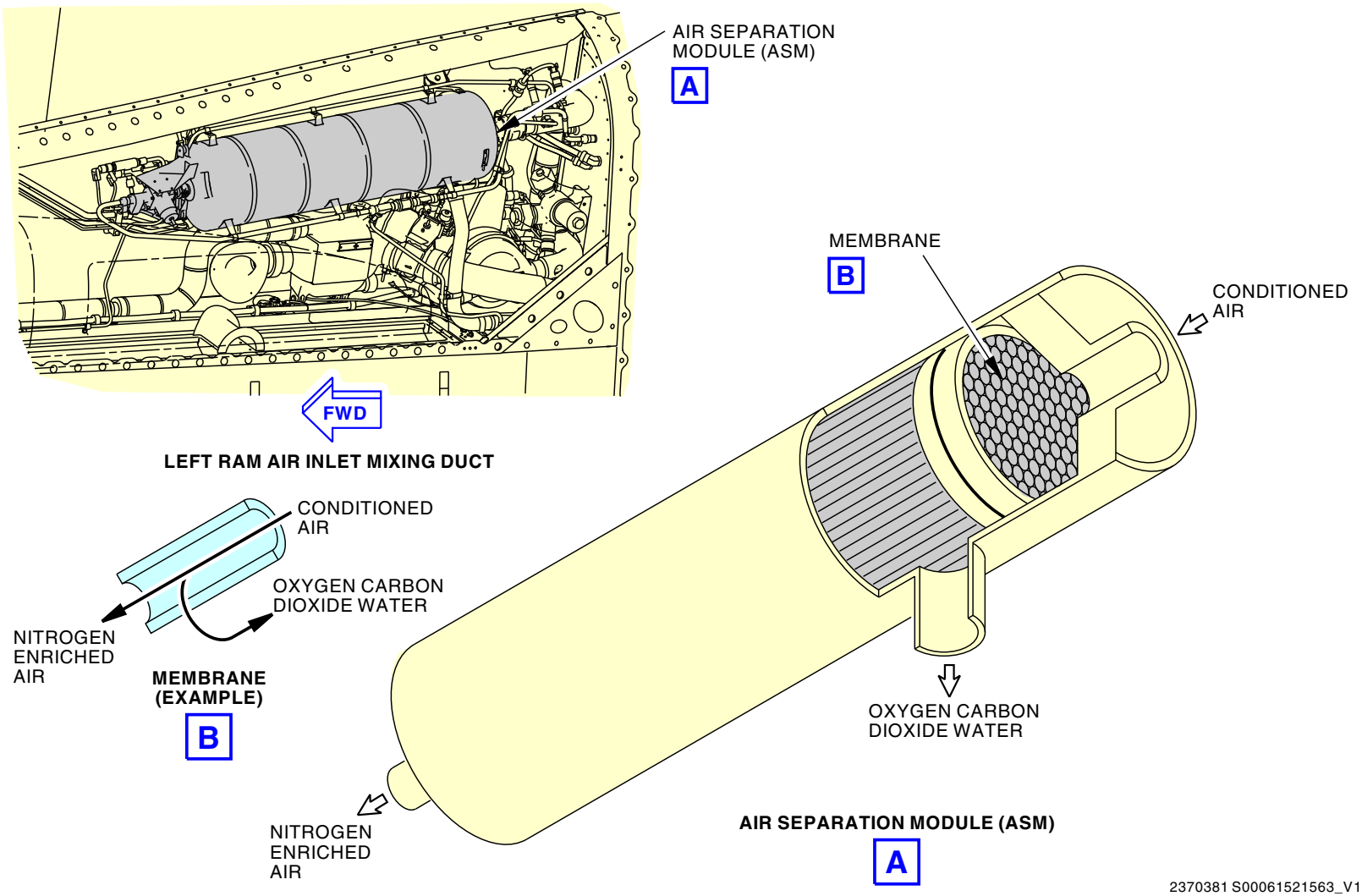
AIR SEPARATION MODULE - INTRODUCTION

AIR SEPARATION MODULE - FUNCTIONAL DESCRIPTION

Functional Description

The air separation module (ASM) has a membrane of thousands of thin fibers. Cool (160 ±10°F (71 ±6°C)) conditioned air goes into the ASM through the inlet manifold. The conditioned air goes through the membrane, which removes oxygen molecules, carbon dioxide molecules, and water from the air. The oxygen enriched air (OEA) flows out of the module to the OEA exhaust duct. The remaining nitrogen enriched air (NEA) flows out of the air separation module to the center tank.

AIR SEPARATION MODULE - FUNCTIONAL DESCRIPTION



2370381 S00061521563_V1

AIR SEPARATION MODULE - FUNCTIONAL DESCRIPTION

HIGH FLOW VALVE - INTRODUCTION

Purpose

The high flow valve supplies low flow volume and high flow volume of nitrogen enriched air (NEA) to the center tank.

The high flow valve closes in the low flow mode and occurs during climb and cruise phases of flight. This conserves conditioned air, gives protection to the heat exchanger, and extends the air separation module operation life.

The high flow valve opens in the high flow mode and occurs during the descent phase of flight. It supplies NEA necessary to pressurize the center tank. The higher nitrogen flow decreases the quantity of ambient air that comes in through the surge tank vent.

Location

The high flow valve is in the left ram air duct compartment. It is behind the ram air duct access panel.

Physical Description

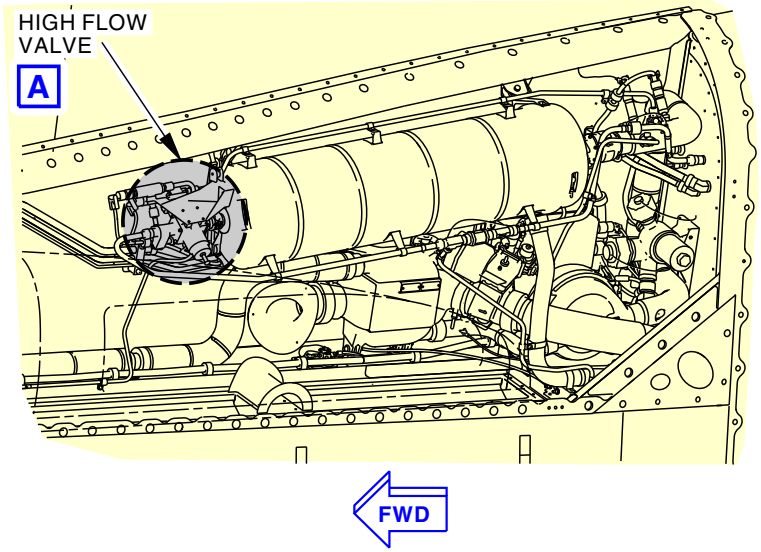
The high flow valve is electrically controlled and pneumatically operated gate valve. It is spring loaded to the low flow position (closed) and open for high flow operation.

These are the components of the high flow valve:

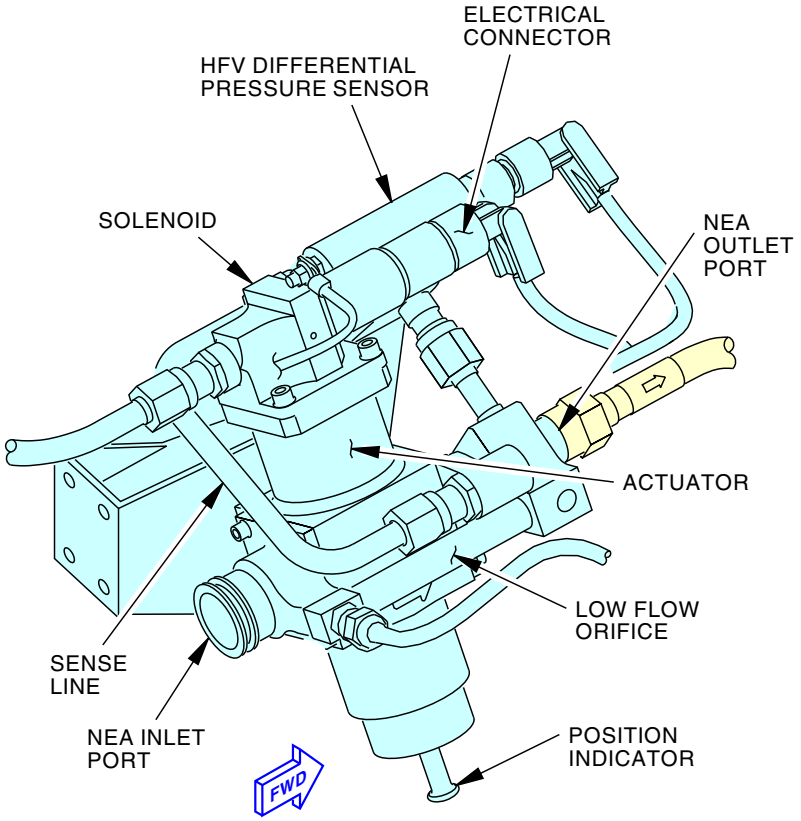
- Solenoid
- Electrical connector
- Sense line
- Actuator
- Position indicator
- Low flow orifice
- Oxygen sense line.

A HFV differential pressure sensor is connected to the high flow valve. It senses pressure differences between the NEA inlet port and NEA outlet port. The NGS controller uses this data, altitude, and airplane systems data to set the valve position.

HIGH FLOW VALVE - INTRODUCTION



LEFT RAM AIR INLET MIXING DUCT



HIGH FLOW VALVE

A

2370382 S00061521565_V1

HIGH FLOW VALVE - INTRODUCTION

HIGH FLOW VALVE - FUNCTIONAL DESCRIPTION

Functional Description

The high flow valve is electrically controlled and pneumatically operated.

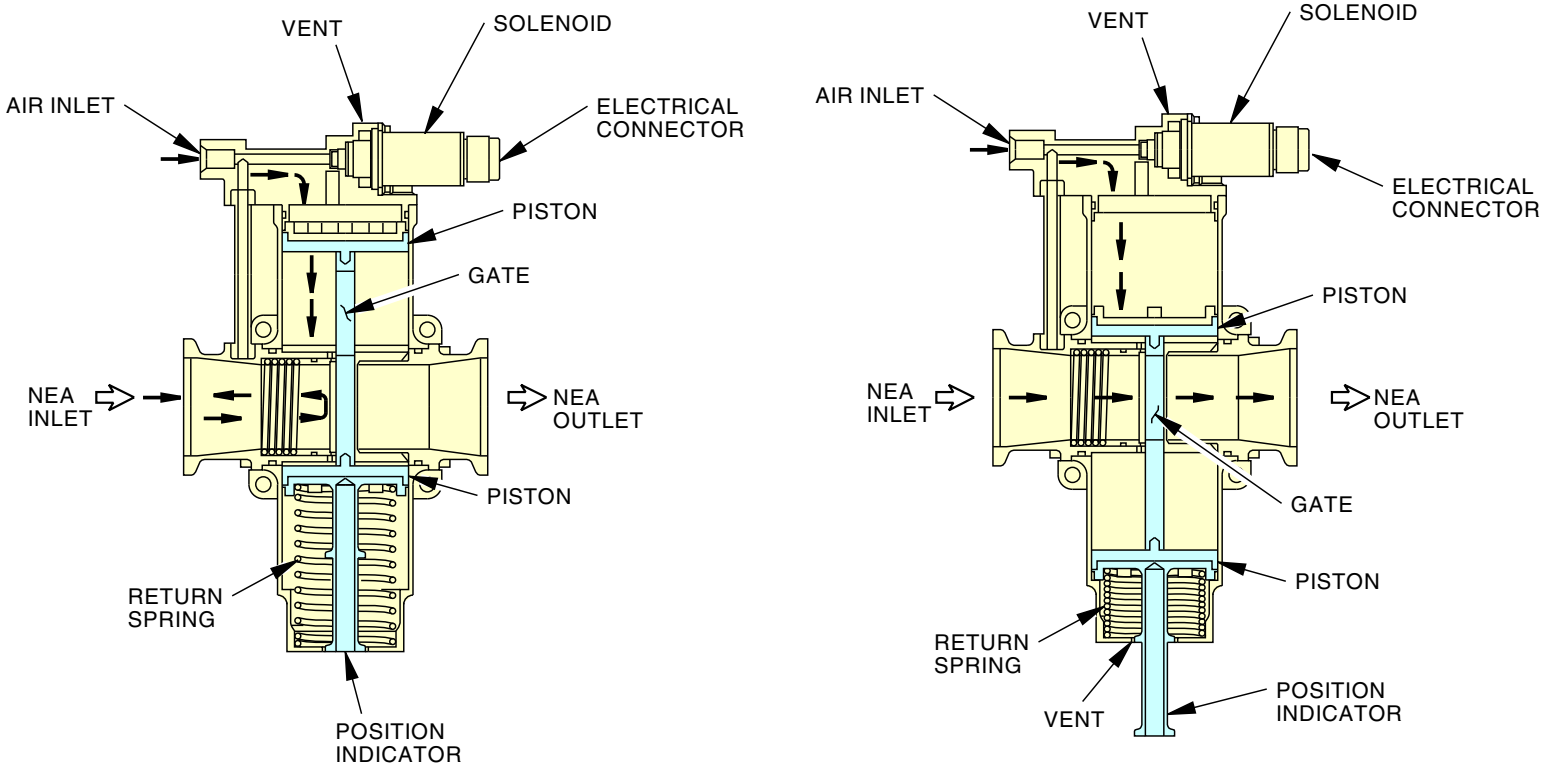
When the solenoid is de-energized, the valve sends air pressure below the piston, and vents through the solenoid to ambient air. The return spring automatically closes the gate. Air passes around the gate through the low flow orifice.

When the solenoid is energized, air pressure at the air inlet is sent through the solenoid. The air pressure on the piston is sufficient to overcome the return spring and open the gate.

The high flow valve has a position indicator that retracts when the gate closes and extends when the gate opens.

An oxygen sense line near the NEA inlet supplies nitrogen enriched air to the NGS oxygen sensor.

HIGH FLOW VALVE - FUNCTIONAL DESCRIPTION



2370383 S00061521567_V1

HIGH FLOW VALVE - FUNCTIONAL DESCRIPTION

NGS OXYGEN SENSOR

General

The NGS oxygen sensor is a self-contained, solid state gas analyzer and pressure sensor. The NGS oxygen sensor measures the oxygen content and absolute pressure from the air separation module (ASM). This data is then supplied to the NGS controller for system status monitoring. The oxygen sensor operates once per flight leg, on command from the NGS controller.

Location

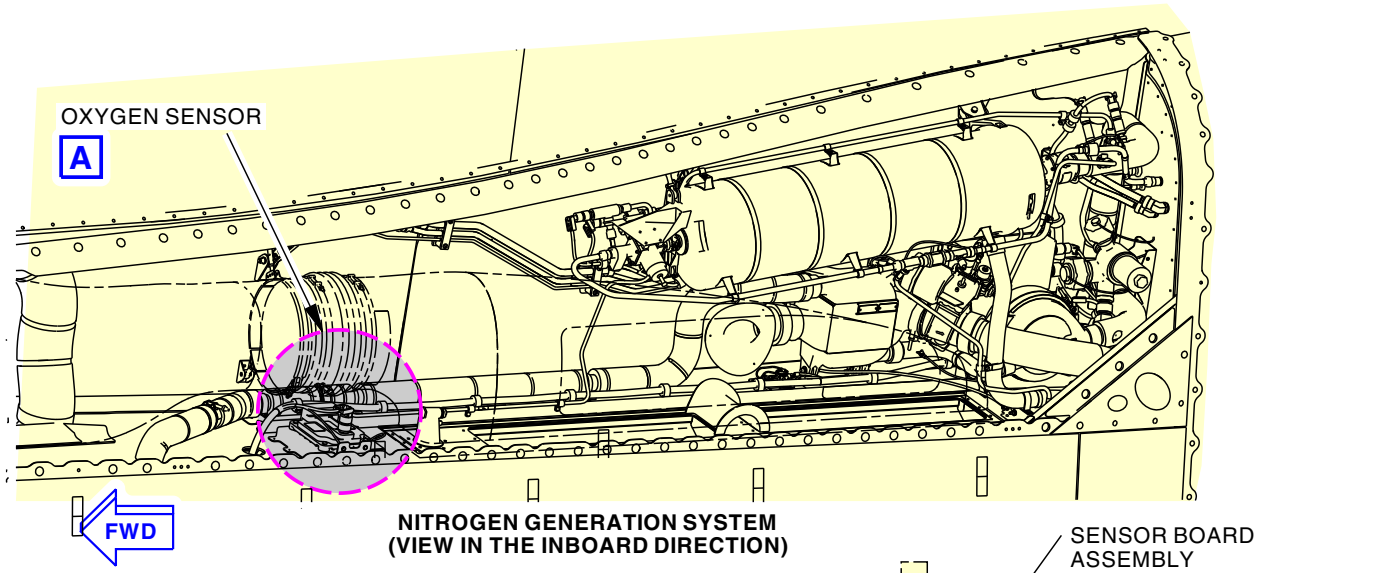
The NGS oxygen sensor is installed in the forward-left ram air duct compartment.

Operation

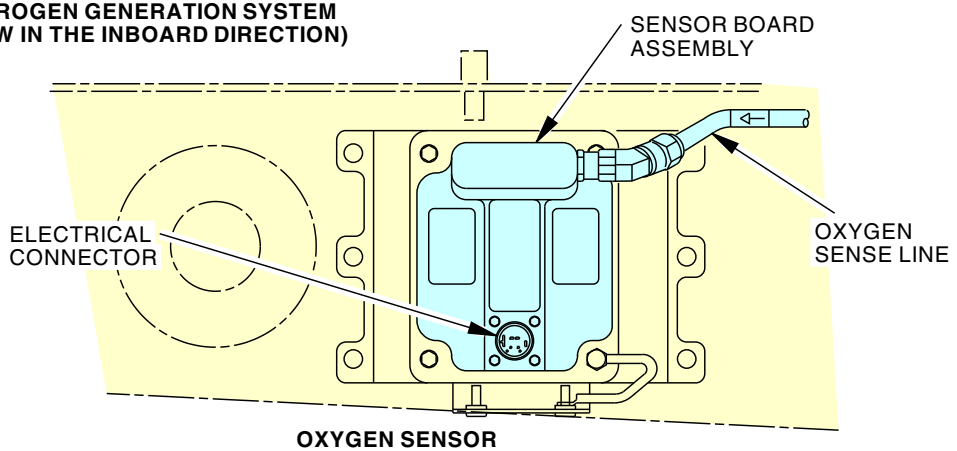
The NGS oxygen sensor monitors the ASM oxygen concentration from the oxygen sense line. The NGS oxygen sensor the transmits the absolute pressure and oxygen concentration to the NGS controller.

The NGS oxygen sensor does a self-check and outputs 2 mA to show a fault. When a fault occurs, the output is set at the last valid output state until the fault is confirmed. If the fault clears in 10 seconds, the output returns to normal operation.

NGS OXYGEN SENSOR



NITROGEN GENERATION SYSTEM
(VIEW IN THE INBOARD DIRECTION)



OXYGEN SENSOR
(VIEW IN THE INBOARD DIRECTION)

A

2370384 S00061521569_V1

NGS OXYGEN SENSOR

NEADS - GENERAL DESCRIPTION

Purpose

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

Description

These are the components of the NEADS:

- Drain Cap
- Float Valve
- Cross Vent Check Valve
- Primary Backflow Prevention Check Valve
- Secondary Backflow Prevention Check Valve
- NEADS Tubing
- Dielectric Isolator Hose
- Flame Arrestor
- Ejector Nozzle

Drain Cap

The drain cap is below the air separation module (ASM). The drain cap lets you do a check for fuel or other fluid in the NEADS.

Float Valve

The float valve is attached to vent stringer 12 in the center tank.

The float valve closes automatically when the center tank is full of fuel and opens automatically when fuel decreases. Fuel that goes into the vent stringer, exits into the right surge tank.

When opened, the NEA mixes with the ambient air from the right surge tank.

Cross Vent Check Valve

The cross vent check valve is located in the right surge tank and is usually in the closed position.

The cross vent check valve stops ambient air from going into the center tank from the right surge tank. This lets the NGS pressurize the center tank with NEA. The cross vent check valve opens to let fuel into the surge tank when there is an overfill event.

Backflow Prevention Check Valves

The backflow prevention check valves prevents fuel flow back into the ASM. The vent channel stays open if an air bubble is present in the center tank. Fuel can go into the vent channel for these conditions:

- The system fills the fuel tank to VTO and is inactive for long periods of time.
- Warm weather expands fuel in the fuel tanks.
- You refuel the airplane when it is not level.
- A rejected takeoff.
- Ground maneuvers.

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

The secondary backflow prevention check valve is in the left ram air duct bay behind the ram air access panel. It is on the NEADS tubing, between the drain valve and the O_2 GSE port.

NEADS Tubing

The NEADS tubes consists of aluminum tubes and fittings. It moves the created NEA from the ASM into the center tank.

Dielectric Isolator Hose

The dielectric isolator hose protects the center tank from electrostatic discharge and lightning strikes. It is located in the left main wheel well and attached to the flame arrestor on the rear spar.

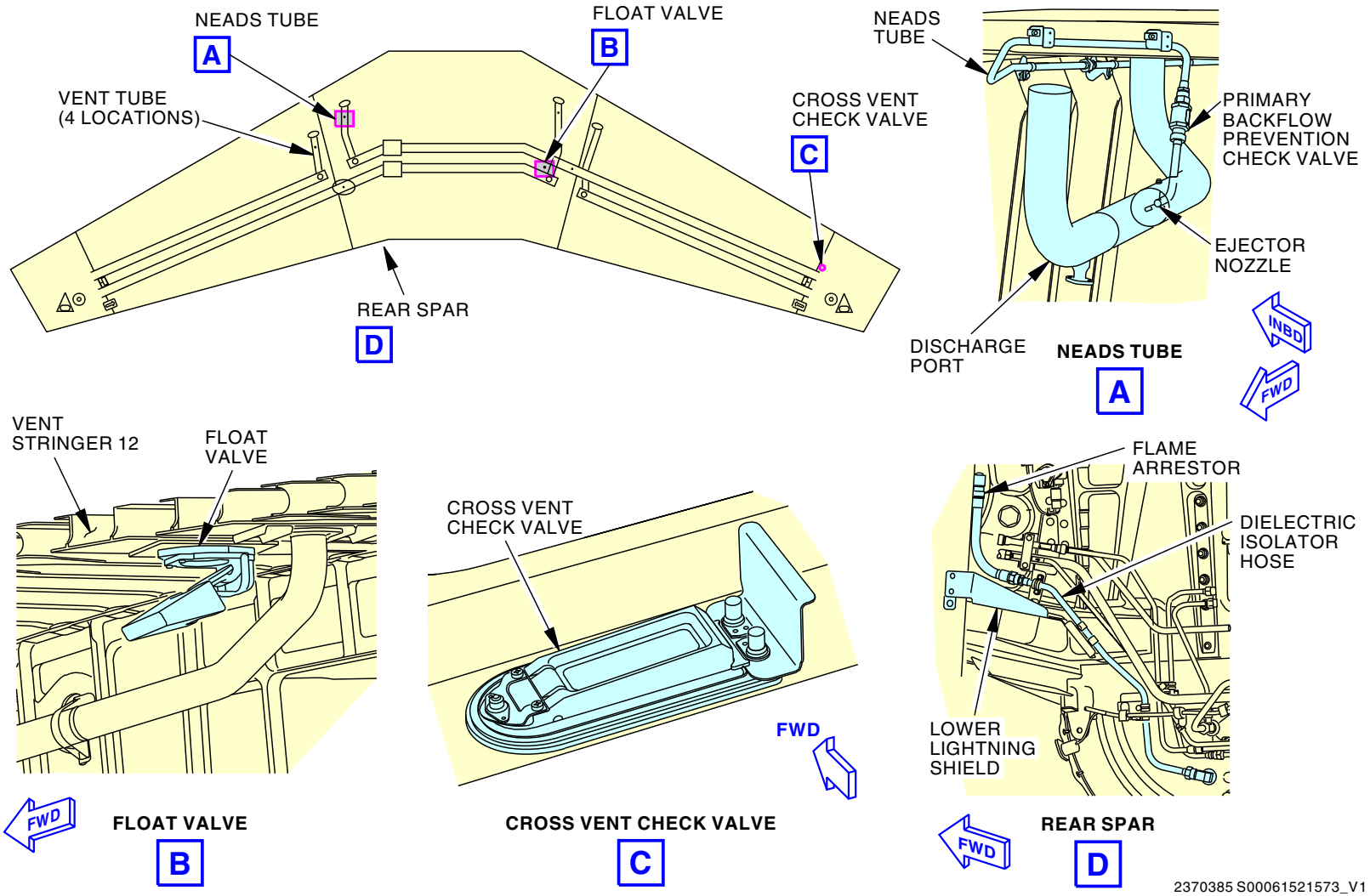
Flame Arrestor

The flame arrestor is an in-line honeycomb unit, designed to protect against lightning caused ignition. The flame arrestor is installed into a bulkhead fitting and attached to the rear spar on the center tank.

Ejector Nozzle

The ejector nozzle is where the NEA goes into the center tank. It is welded to a vent tube on the left side of the center tank. The ejector nozzle and the float valve work together. They mix the air into a satisfactory oxygen decreased atmosphere that will not support combustion.

NEADS - GENERAL DESCRIPTION



2370385 S00061521573_V1

NEADS - GENERAL DESCRIPTION

NEADS - COMPONENT LOCATION - 1

General

The components of NEADS are in the left ram air compartment and in the fuel distribution system.

Components - Left Ram Air Compartment

These components are in the left ram air bay (View C):

- Ground Service Equipment (GSE) O_2 Test Port
- Secondary Backflow Prevention Check Valve
- Drain Cap.

Components - Left Wheel Well

These components are in the left wheel well attached to the center tank rear spar (View A):

- Dielectric Isolator Hose
- Lighting Shield
- Flame Arrestor

SIA 015-999; SIA 001-014 POST SB 737-47-1019

- Drain Cap.

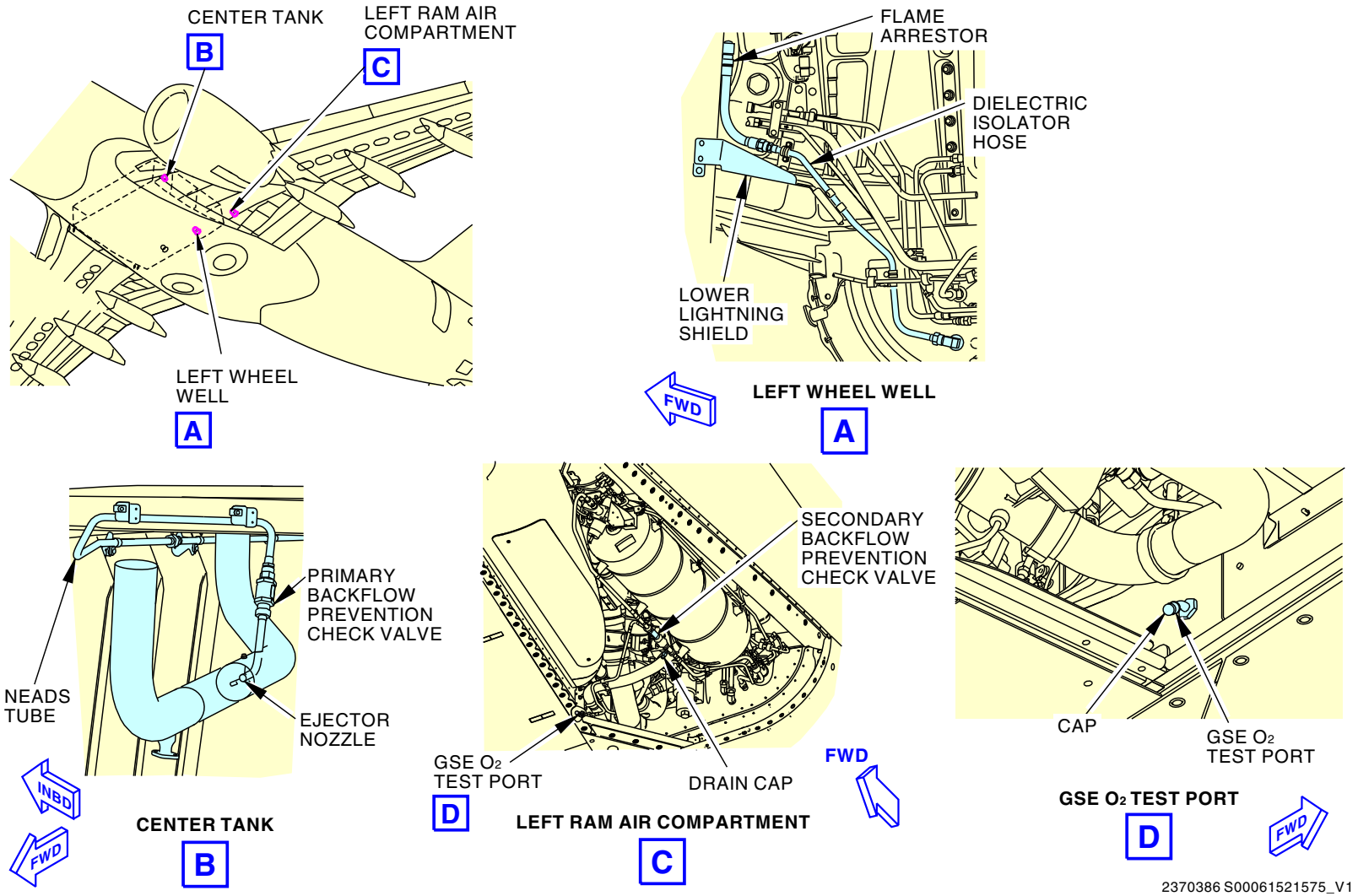
SIA ALL

Components - Center Tank - Left Side

These components are in the left cheek of the center tank (View B):

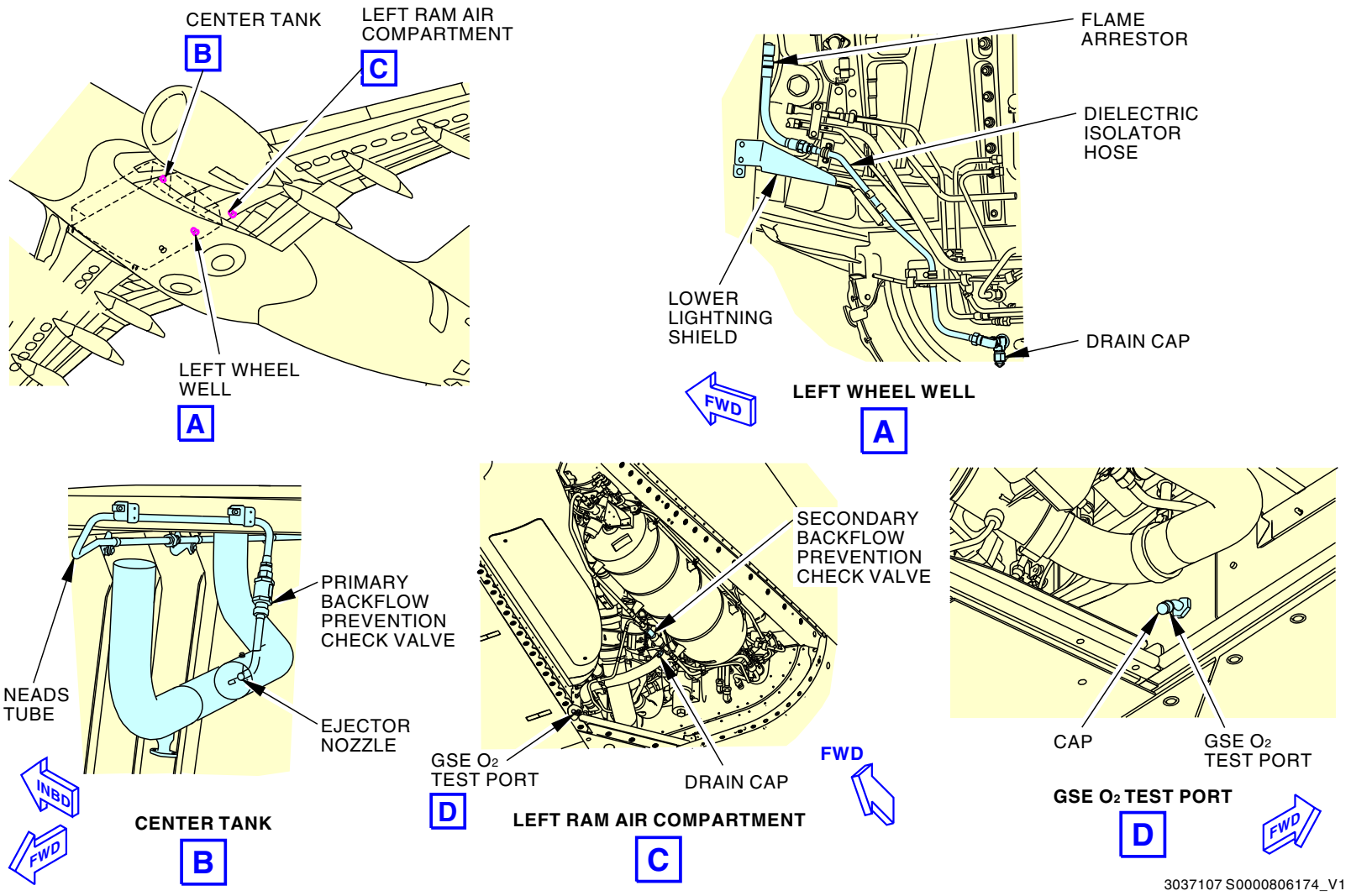
- Primary Backflow Prevention Check Valve
- Ejector Nozzle
- NEADS Tube.

NEADS - COMPONENT LOCATION - 1



NEADS - COMPONENT LOCATION - 1

NEADS - COMPONENT LOCATION - 1



NEADS - COMPONENT LOCATION - 1

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NEADS - COMPONENT LOCATION - 2

General

These NEADS components are located in the center tank and right surge tank.

Components - Center Tank - Right Side

The right cheek (side) of the center tank has these components:

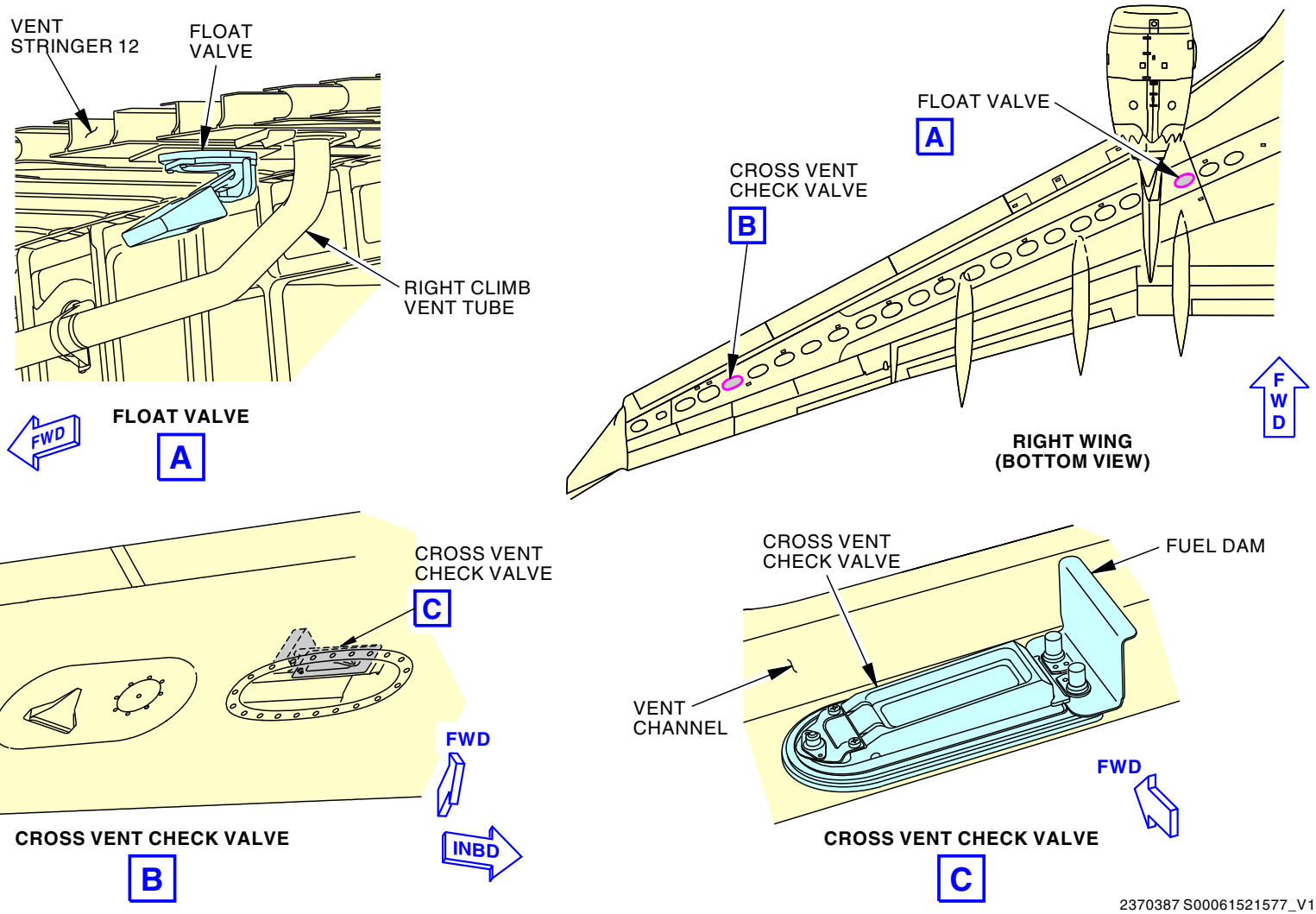
- Float Valve.

Components - Right Surge Tank

The right surge tank has these components:

- Vent Channel
- Cross Vent Check Valve
- Fuel Dam.

NEADS - COMPONENT LOCATION - 2



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NEADS - COMPONENT LOCATION - 2

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NGS CONTROLLER

Purpose

The Nitrogen Generation System (NGS) is an automated system that is controlled by the NGS controller. It collects data from the airplane system, and monitors the conditioned air temperature and bleed air pressure.

The NGS controller collects data from the airplane systems and different NGS sensors.

Location

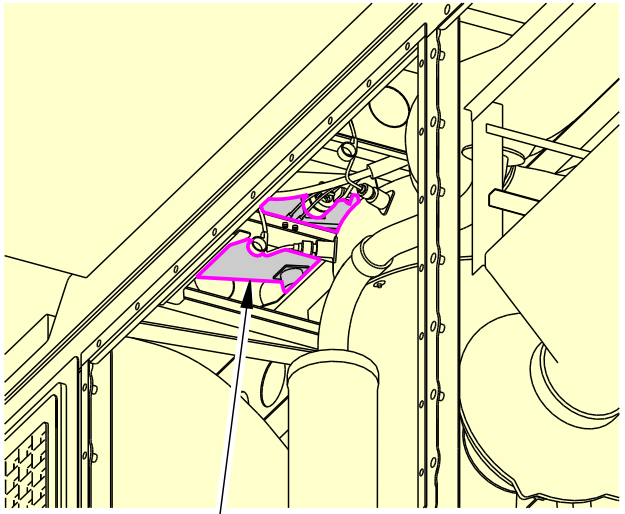
The NGS controller is aft of the forward cargo compartment.

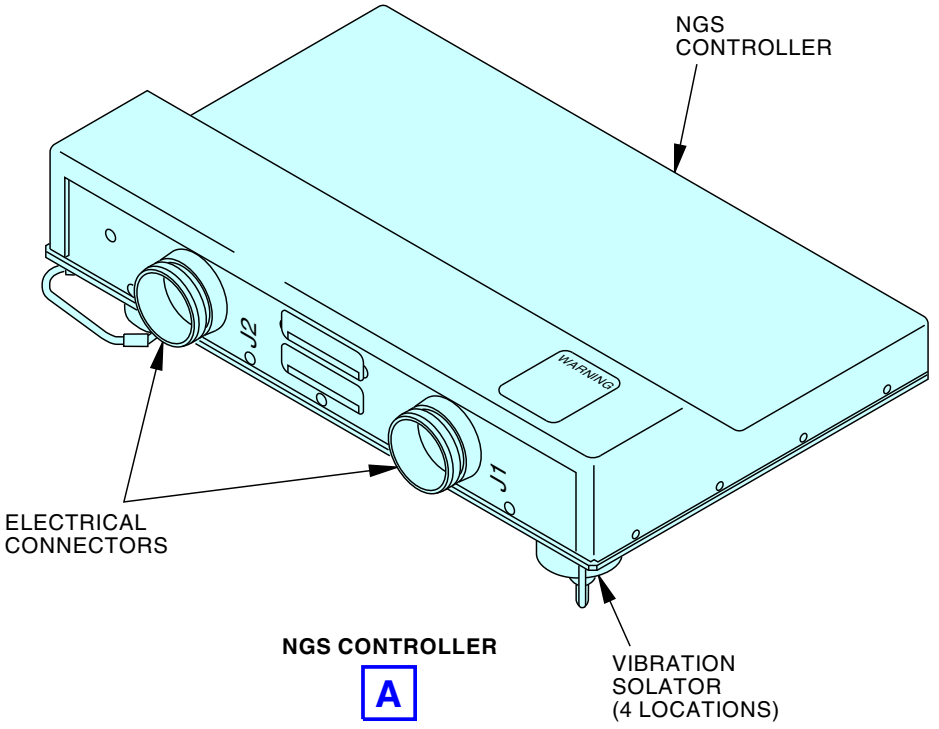
Physical Description

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

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

NGS CONTROLLER





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NGS CONTROLLER

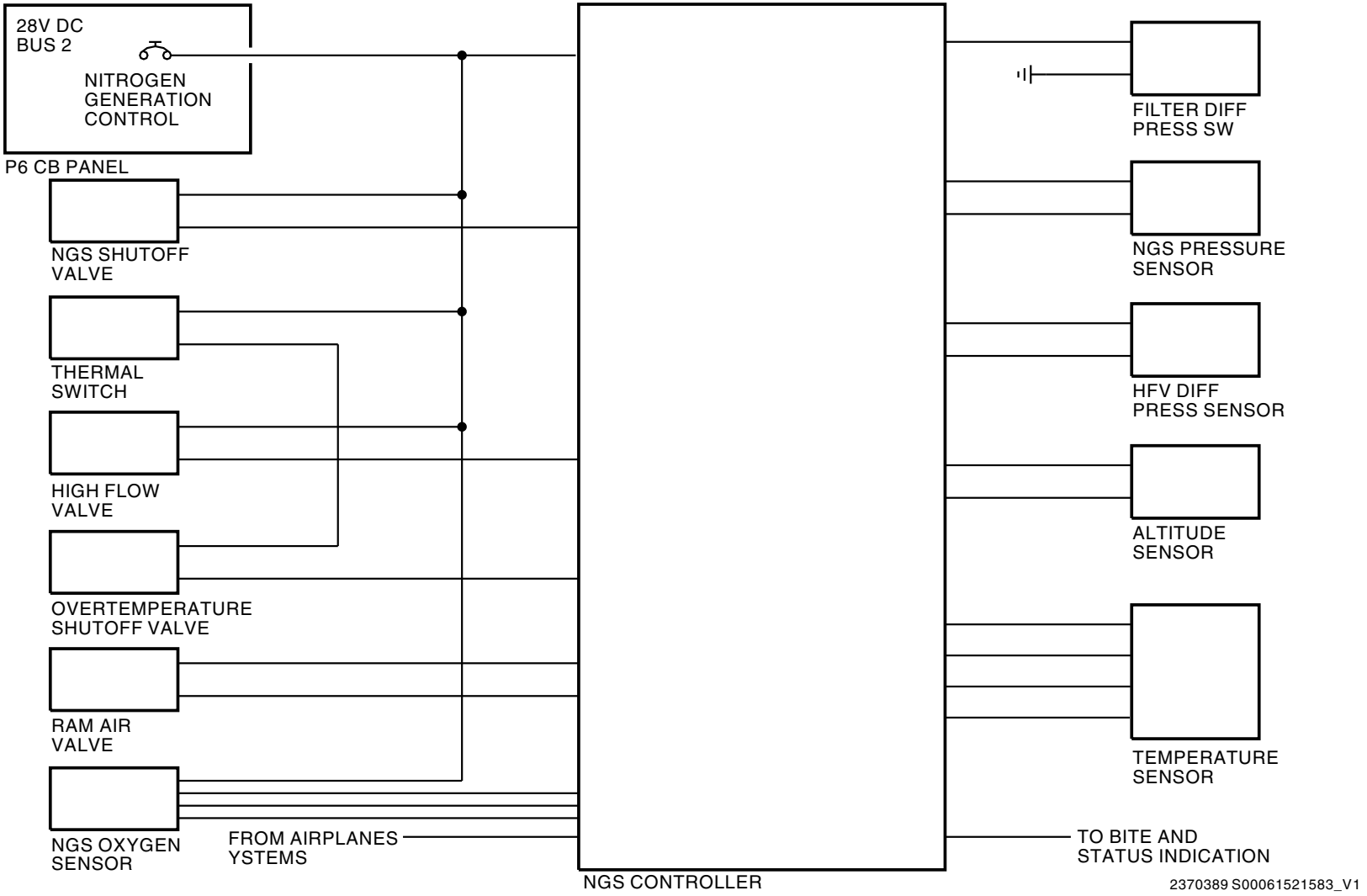
NGS CONTROLLER - FUNCTIONAL DESCRIPTION

Functional Description

The NGS controller does these functions:

- Modulates the ram air valve to control the bleed air temperature that goes into the air separation module
- Commands the NGS shutoff valve to open or close
- Commands the overtemperature shutoff valve to open or close
- Monitors overtemperature conditions
- Sends indications to the BITE display unit
- Senses when the conditioned air flow decreases
- Gets data from the high flow valve differential pressure sensor
- Does the electrical built-in-test
- Supplies RS422 communication to downloaded software and monitors controller data
- Gives a visual condition of the NGS to the operability indicator
- Records flight data in non-volatile memory
- Monitors the air separation module performance
- The NGS oxygen sensor senses high concentration of oxygen from the air separation module

NGS CONTROLLER - FUNCTIONAL DESCRIPTION



NGS CONTROLLER - FUNCTIONAL DESCRIPTION

NGS CONTROLLER - DISCRETE INPUTS

General

The Nitrogen Generation System (NGS) controller gets discrete inputs from these airplane sources to control 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
Left Pack Flow Control and Shutoff Valve (FCSOV)	Left FCSOV Limit Switch Position	True = OFF
Air Conditioning Relays	Flap Position for Mode of Flight	High or Low Flow
System 1 Air Ground Relay	Weight-On-Wheels (WOW) - On Ground	True = OFF
Engines 1 and 2 Running Relays	If either engine shutdown in flight	True = OFF
Center Tank Refuel Valve	Valve Position - Open	True = OFF

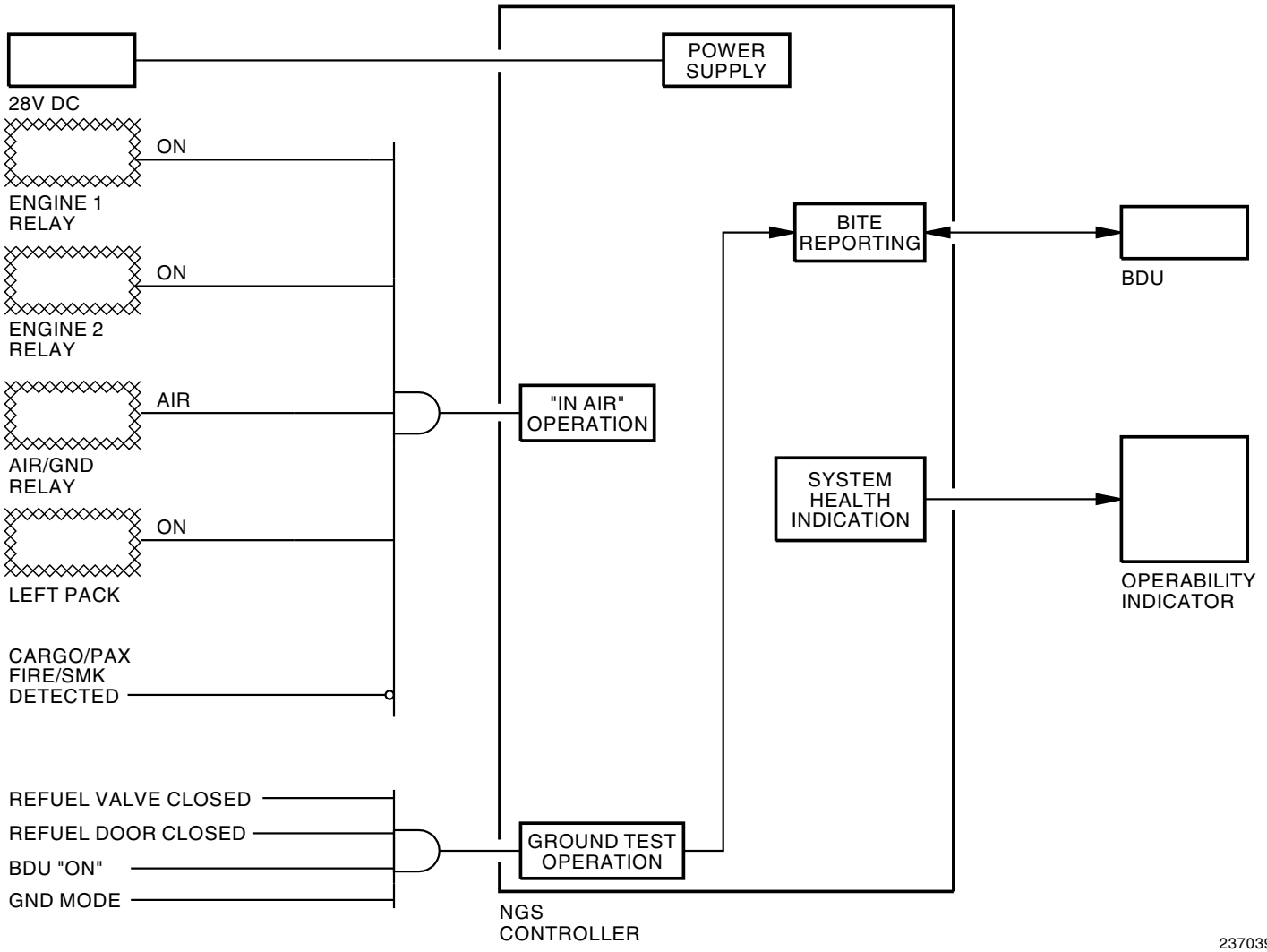
Analog discrete inputs tell the NGS controller the position of an airplane system valve or the electrical condition of a connection from a sensor (open or ground). The controller opens the NGS Pressure Regulating and Shutoff Valve (PRSOV) during flight normal conditions and lets bleed air into the system. The NGS controller opens the NGS PRSOV when these conditions occur:

- The airplane is in the air
- Each engine is operating
- The cargo smoke detection and suppression module is normal
- The center tank refuelling valve is closed.

When the NGS PRSOV is closed, the NGS system is off. The NGS PRSOV closes for one of these conditions:

- The airplane is on the ground and not in test mode
- Each engine is off in-flight
- Fire or smoke detection in cargo or main deck areas
- The center tank refuelling valve is open
- Airplane on the ground and Left FCSOV Limit Switch Position is CLOSED
- After 10 minutes of ground operation when the left FCSOV Limit Switch Position is OPEN
- Overpressure shutdown of the NGS bleed sensor > 67 psig (67 psi)
- Sensor or interface fault of both elements of the NGS temperature sensor
- Air Separation Module (ASM) over-temperature protection engaged
- Invalid Aircraft ID.

NGS CONTROLLER - DISCRETE INPUTS



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NGS CONTROLLER - DISCRETE INPUTS

NGS CONTROLLER - DISCRETE INPUTS

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NGS INDICATION - OPERABILITY INDICATOR

Purpose

The operability indicator shows the condition of the nitrogen generation system (NGS).

Location

The operability indicator is on the aft bulkhead of the right main landing gear wheel well. It is adjacent to the APU remote control panel (P28).

Physical Description

The indicator has these three lights that show the condition of the NGS:

- OPERATIONAL - Green light
- DEGRADED - Blue light
- INOP - Amber light

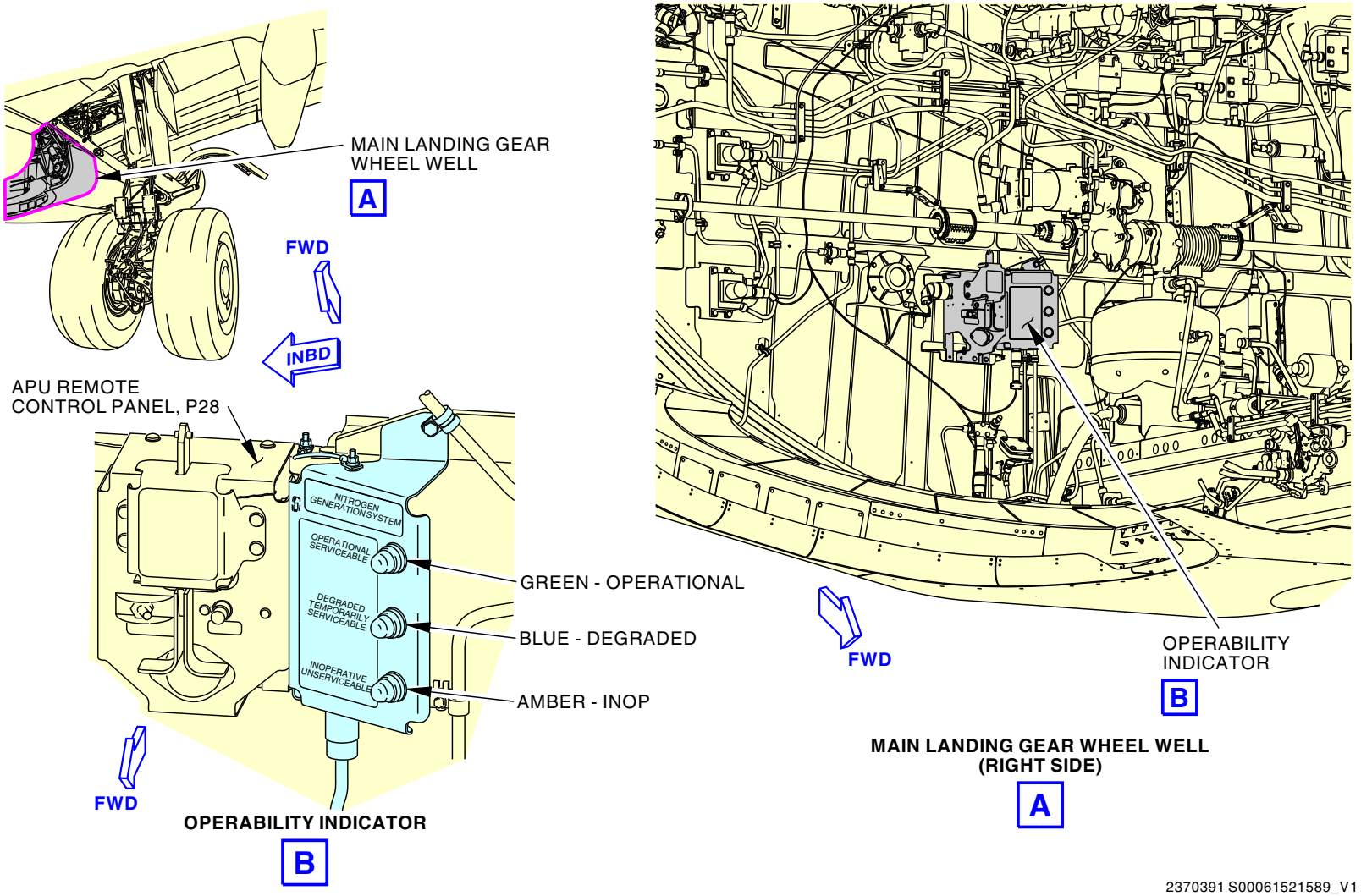
The green OPERATIONAL light shows that the system operates correctly, and no maintenance is necessary.

The blue DEGRADED light shows that the system is serviceable, but at a decreased capacity. No maintenance is necessary, but you must record the fault before you can release the airplane.

The amber INOP light shows that the system is not serviceable. The NGS shutoff valve must manually be closed and locked. Record the faults before the airplane is released.

When none of the lights shows, the operability indicator is not serviceable. Use the BITE display unit to find the cause of the problem.

NGS INDICATION - OPERABILITY INDICATOR



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OPERABILITY INDICATOR

EFFECTIVITY

SIA ALL

NGS INDICATION - BITE DISPLAY UNIT

Purpose

The BITE display unit (BDU) is used to troubleshoot the nitrogen generation system components and system.

Location

The BDU is in the forward bulkhead of the right ECS air conditioning compartment. Access to the BITE display unit is through the 192DR, ECS High Pressure Access Door.

Physical Description

The BITE display unit has these items:

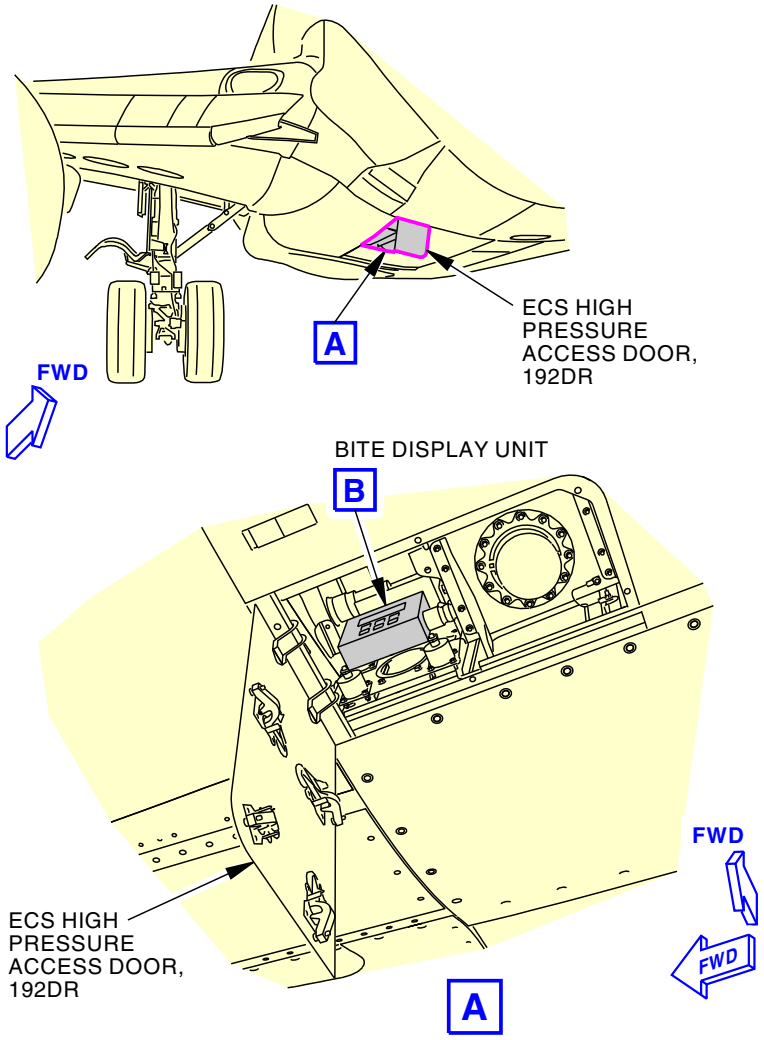
- BITE instruction plate
- Two line LED display
- Six push-buttons.

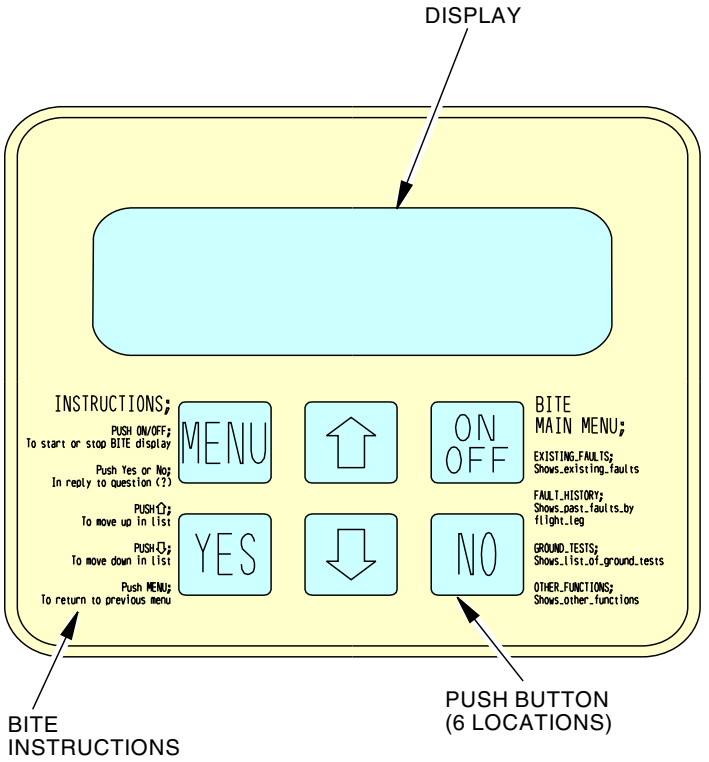
BITE Display Unit - Push-Button Controls

These are the functions of the BITE display unit push-buttons:

- ON/OFF push-button - Activate or deactivate the BITE display unit.
- MENU push-button - Return to previous BITE menu or immediately stop a test.
- YES push-button - Respond to a question or start a test.
- NO push-button - Respond to a question.
- Up arrow - Move up through a menu list or the test result list.
- Down arrow - Move down through a menu list or the test result list.

NGS INDICATION - BITE DISPLAY UNIT





BITE DISPLAY UNIT

B

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NGS INDICATION - BITE DISPLAY UNIT

NGS INDICATION - BITE

General

The nitrogen generation system does these BITE functions:

- Continuous monitoring
- BITE tests.

Continuous Monitoring

The continuous monitoring function monitors the nitrogen generation system for correct operation. When the NGS controller finds a 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
- Does tests to show that functions are in specification.
- Aid for fault isolation

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

BITE Operation

To start the BITE, push the ON/OFF push-button 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 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 push-button to go out of a menu and to move up one level to the previous menu.

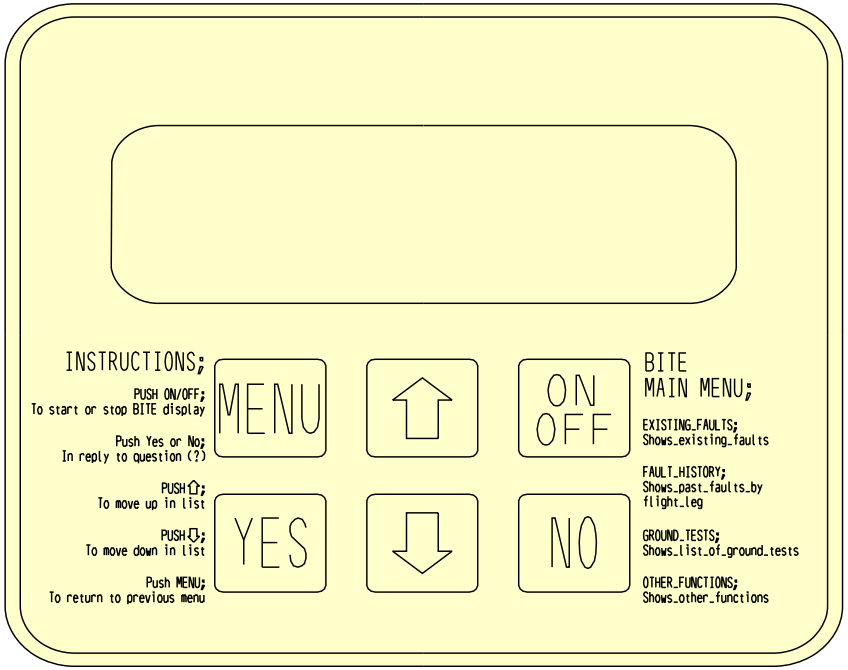
Main Menu

These are the BITE main menu:

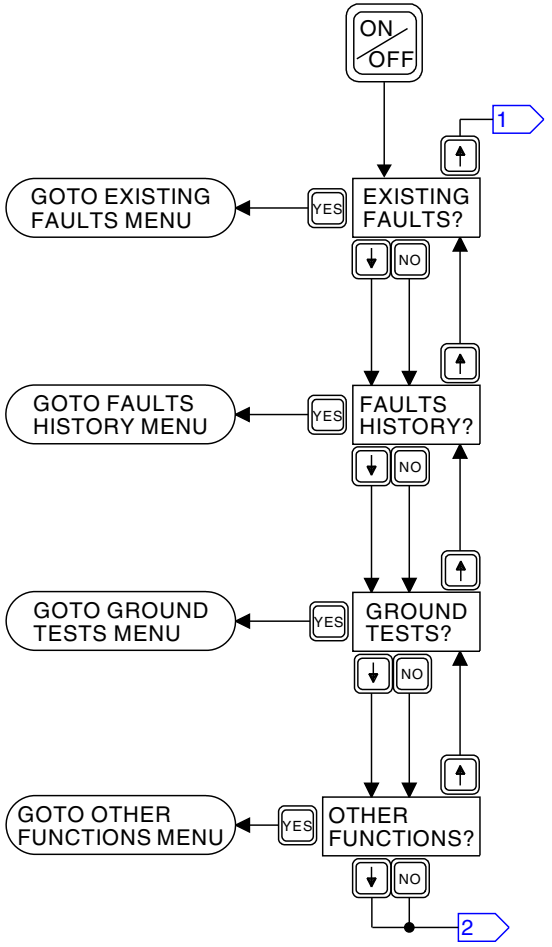
- Existing Faults?
- Fault History?
- Ground Tests?
- Other Functions?

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

NGS INDICATION - BITE



BITE DISPLAY UNIT



1 SHOWS TOP OF LIST

2 SHOWS END OF LIST

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NITROGEN GENERATION SYSTEM - BITE

NGS INDICATION - BITE - EXISTING FAULTS

Existing Faults

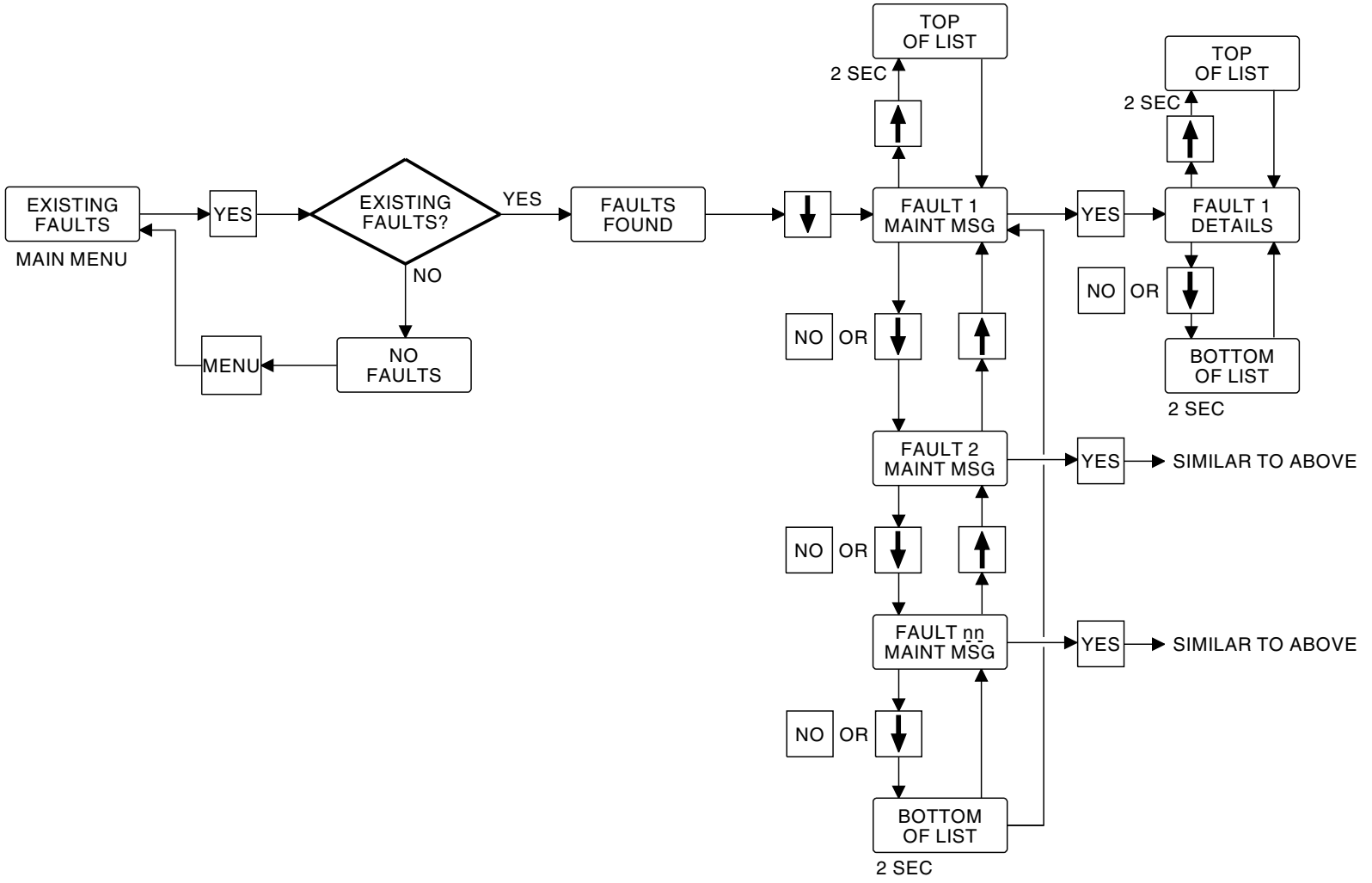
The EXISTING FAULTS? menu shows faults that are present in the system. From the EXISTING FAULTS? menu you can select faults to examine. Faults are maintenance messages. Fault details give more data about the problem.

From the EXISTING FAULTS? menu, push the YES push-button. If there are no faults, the display shows NO FAULTS. Push the MENU push-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. 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 push-button. The display shows the details for that fault. If you push the NO push-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.

NGS INDICATION - BITE - EXISTING FAULTS



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NGS INDICATION - BITE - EXISTING FAULTS

NGS INDICATION - BITE - FAULT HISTORY

Fault History

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

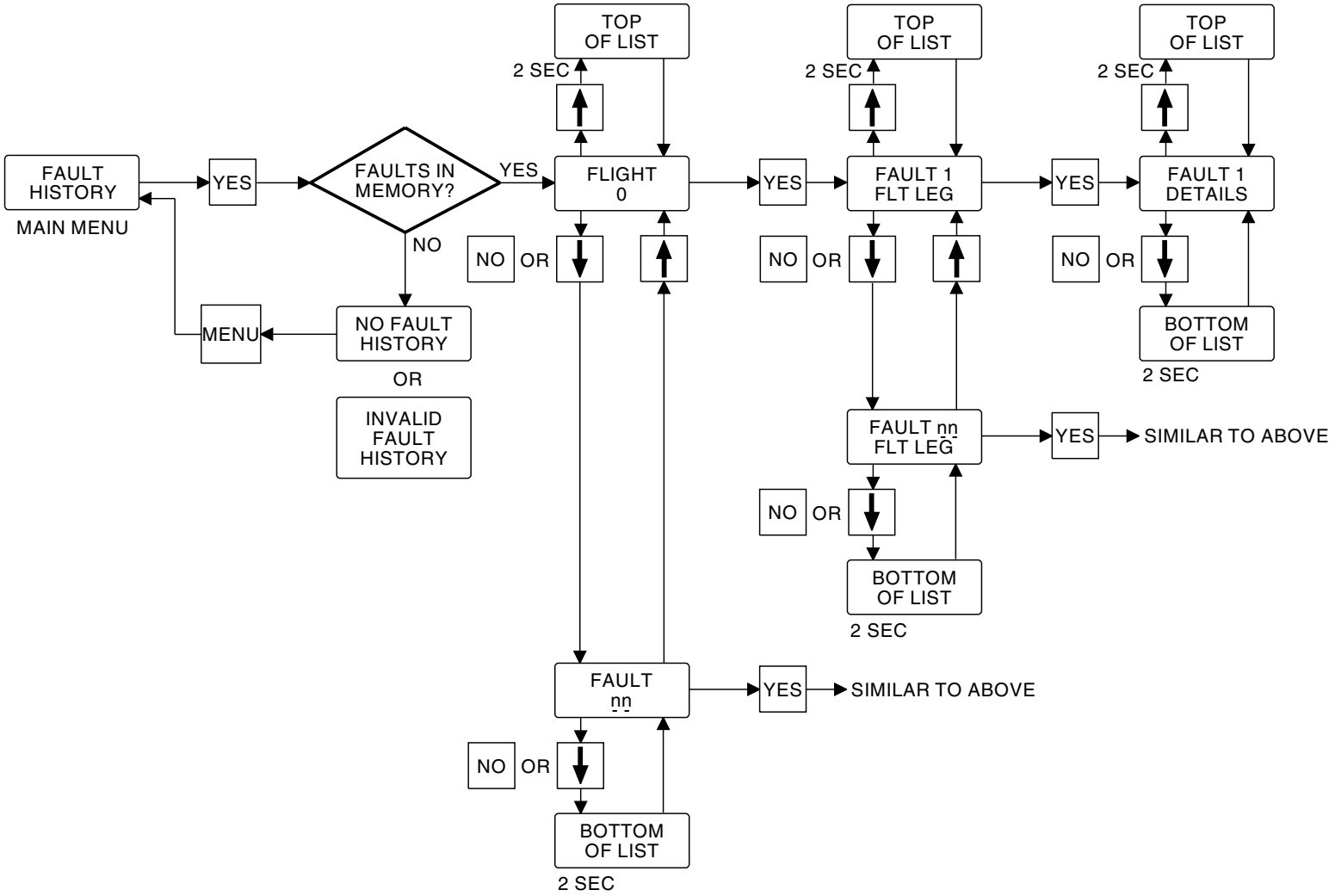
From the FAULT HISTORY? menu, push the YES push-button. If there are no faults in memory, NO FAULT HISTORY shows on the display. Push the MENU push-button to go back to the main menu.

If there are faults, the display shows 00 for the most recent fault. To show the previous flight leg, push the NO or down arrow. The display shows 01 as the previous flight leg. If there are no more faults in memory, the display shows BOTTOM OF LIST for 2 seconds. The NGS controller can save 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 push-button. The display shows the fault. If you push the NO or 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 push-button. If you want to see more fault details, push the NO or down arrow. If there are no more fault details, the display shows BOTTOM OF LIST for 2 seconds.

NGS INDICATION - BITE - FAULT HISTORY



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NGS INDICATION - BITE - FAULT HISTORY

NGS INDICATION - BITE - GROUND TESTS

Ground Test

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

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

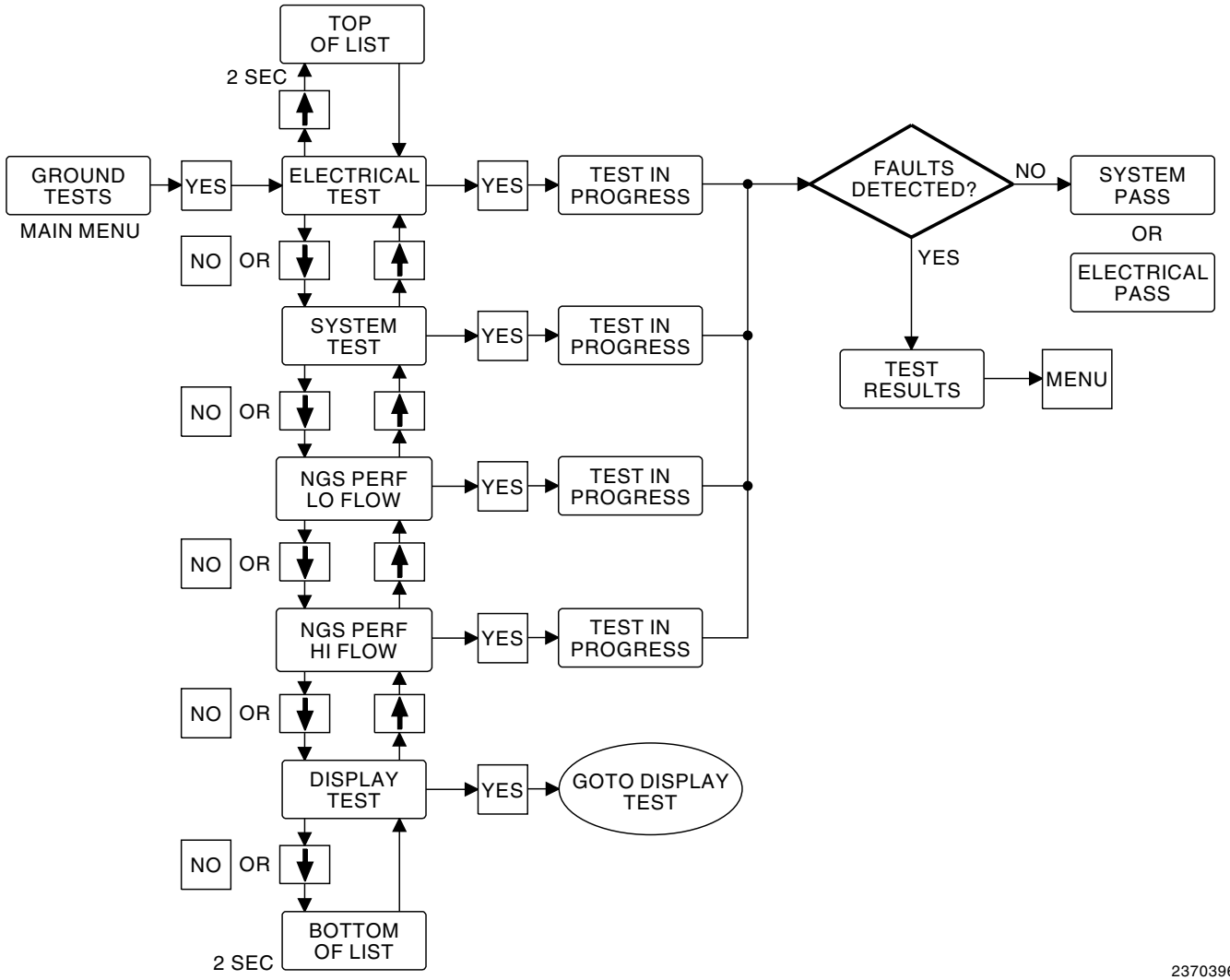
- Electrical Test?
- System Test?
- NGS PEFR LO FLOW?
- NGS PERF HI FLOW?
- Display Test?

When a test is started, the display shows TEST IN PROGRESS.

When there are no faults detected, the display shows SYSTEM OK.

When there is a fault detected after the test is completed, the display shows nn EXIST FAULTS for 2 seconds. It then goes to the EXISTING FAULTS? menu.

NGS INDICATION - BITE - GROUND TESTS



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NGS INDICATION - BITE GROUND TESTS

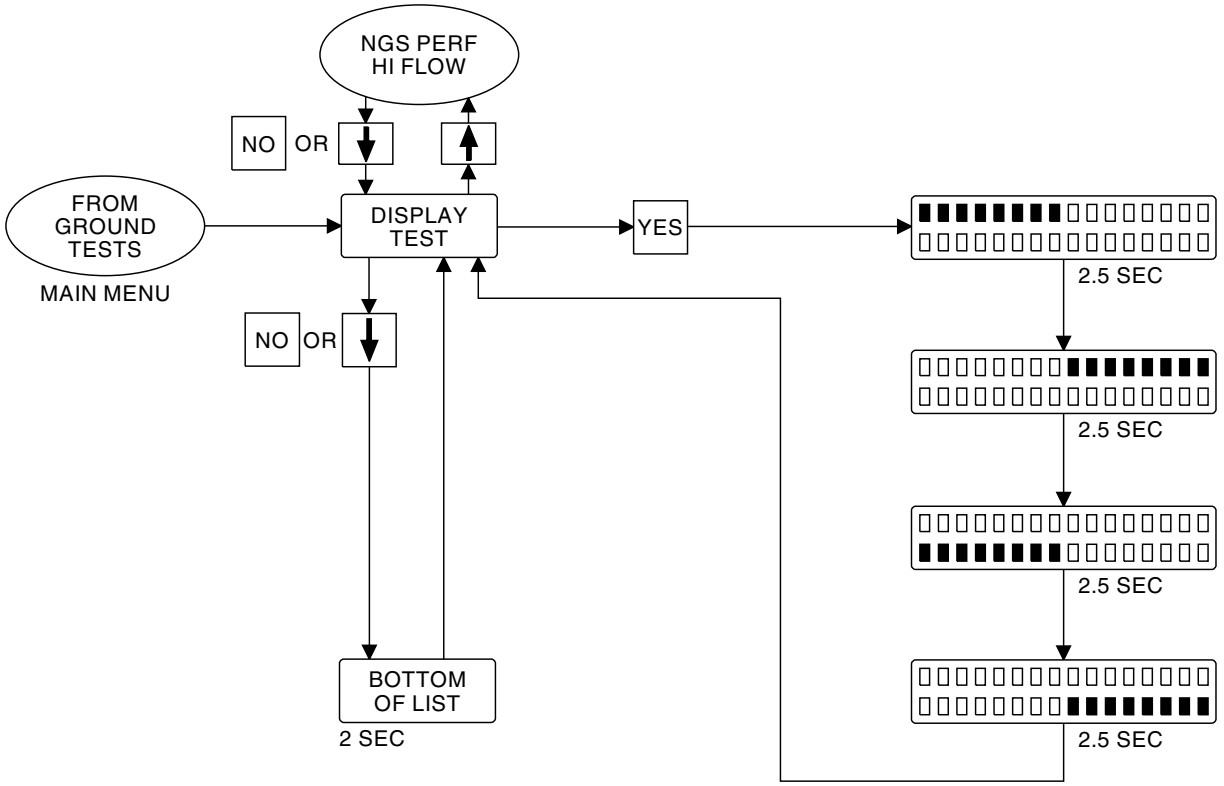
NGS INDICATION - BITE - DISPLAY TEST

Display Test

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

From the GROUND TEST menu, push the YES push-button. The display shows DISPLAY TEST. Push the YES push-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.

NGS INDICATION - BITE - DISPLAY TEST



LEGEND:

- ■ BDU LIGHT ON
- □ BDU LIGHT OFF

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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 down arrow. The display shows these selections:

- System Config?
- I/O Monitor?

SYSTEM CONFIGURATION

The system configuration menu gives these selections:

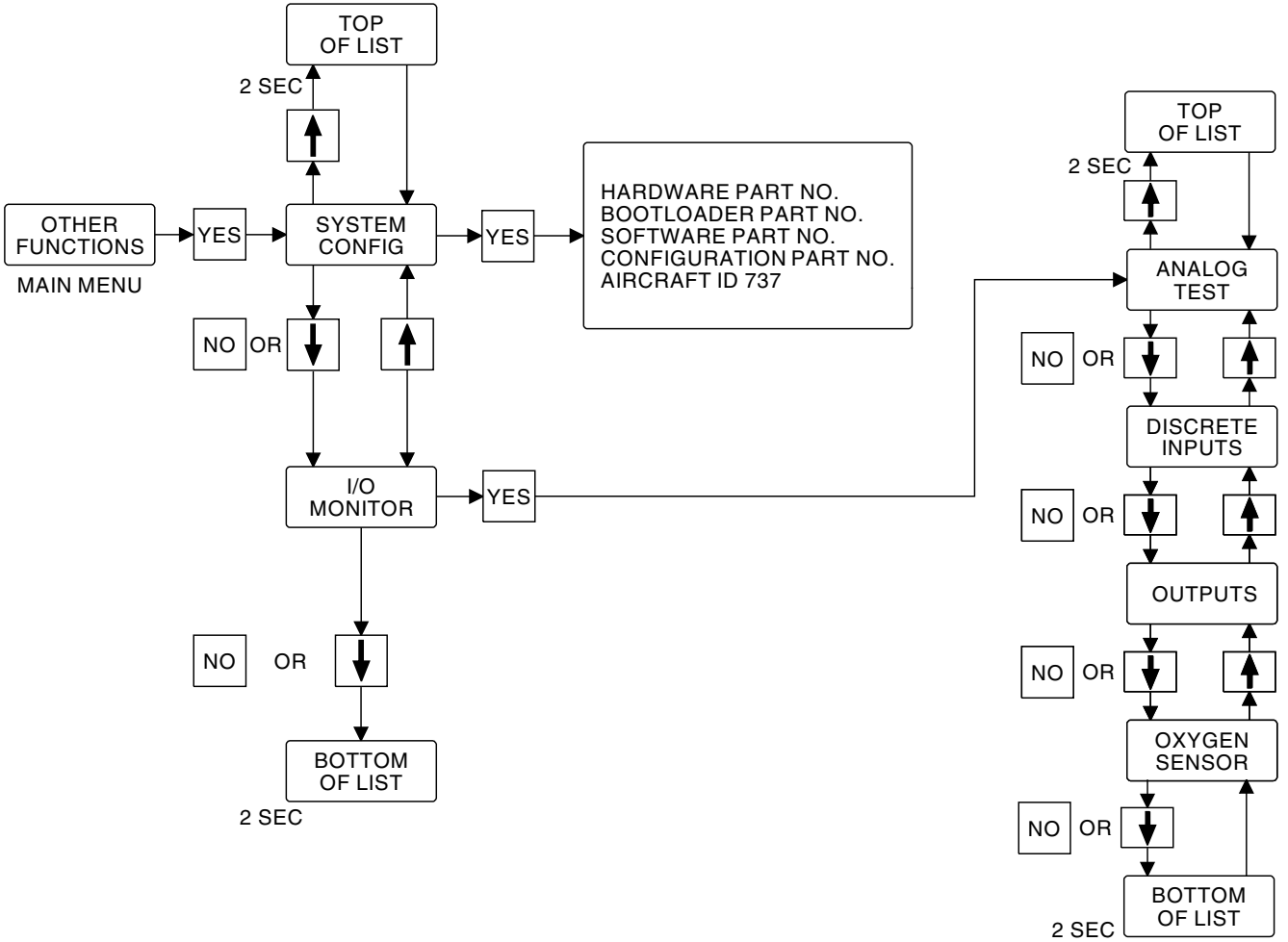
- Hardware Part No:
- Boot Loader Part No:
- Software Part No:
- Config Data Part No:
- Aircraft ID: 737.

I/O MONITOR

The I/O MONITOR menu gives these selections:

- Analog Inputs
- Discrete Inputs
- Outputs?
- Oxygen Sensor?

NGS INDICATION - BITE - OTHER FUNCTIONS



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NGS INDICATION - BITE - OTHER FUNCTIONS