2A-21-10: General

The air conditioning system for the Gulfstream IV is designed to provide all areas within the pressure vessel with a safe and comfortable temperature and pressure (cabin altitude) throughout the aircraft's operating envelope. The system employs a "dual pack" concept and, although each pack is controlled separately, failure of one pack still leaves the remaining pack capable of supplying conditioned air to both cabin and cockpit, if required.

To achieve this function, the air conditioning system provides the flight crew with a means to accomplish the following:

- Control, regulate and monitor the amount of conditioned air within the pressure vessel to achieve and maintain selected or preprogrammed cabin pressure (altitude), while still allowing exchange of the air at regular intervals for occupant comfort. This is accomplished by modulation of a single outflow valve. The outflow valve is automatically controlled by the cabin pressure controller in the normal operating mode, but can be controlled manually.
- Select and control bleed air entering and exiting two environmental control system refrigeration pack assemblies, referred to as the Left and Right ECS Packs. Source air into the ECS Packs is provided to a bleed air manifold by either external air or APU air (while on the ground), or by the aircraft's engines (on ground or in flight). Through use of an isolation valve, air from the bleed air manifold can be directed to either ECS Pack. This results in a constant mass of conditioned air for all areas within the pressure vessel.
- Control the temperature of conditioned air delivered to the cockpit and cabin areas (referred to as zones) within the pressure vessel. This is done using the two ECS packs to cool incoming air and deliver it to a conditioned air manifold. Valves mix hot bleed air with cold conditioned air to modulate the temperature of the air coming from the manifold into the pressure vessel. Cockpit control and indication is also provided.

The Air Conditioning system is divided into the following subsystems:

- 2A-21-20: Pressurization Control System
- 2A-21-30: Airflow and Temperature Control System

2A-21-20: Pressurization System

1. **General Description:**

   The pressurization system controls, regulates and monitors the amount of conditioned air within the pressure vessel to achieve and maintain a safe and comfortable cabin pressure (cabin altitude), up to the airplane's maximum operating altitude. While normally preprogrammed, cabin altitude can also be controlled manually. Cabin conditioned air is also exchanged at regular intervals for occupant comfort.

   With airflow supplied from the ECS packs, the pressurization system maintains cabin altitude by regulating the amount of air exhausted overboard through a single outflow valve. Once the flight crew has programmed the system, operation is virtually automatic.

   The pressurization system is capable of maintaining a cabin altitude of 6,550 feet at a maximum inflight altitude of 45,000 feet. Sea level cabin pressure can be maintained to a maximum inflight altitude of 22,000 feet. If cabin altitude should exceed 10,000 feet, warnings and annunciations are provided to the flight crew so that appropriate action may be taken.

The pressurization system performs the following functions:

- Automatically maintains selected cabin altitude through isobaric pressurized operation
- Automatically limits maximum cabin pressure differential
- Provides safety pressure relief operation
- Provides negative (vacuum) pressure differential control
- Allows manual barometric correction for pre-programmed Landing Field Elevation (LFE)
- Permits manual cabin altitude control through control of the outflow valve
- Automatically limits cabin altitude rate-of-change to a maximum of 3,000 feet-per-minute (FPM) during pressurization and depressurization
- Provides crew-selected cabin altitude rate-of-change
- Regulates and smooths cabin pressurization to prevent pressurization surges or “bumps”
- Provides rapid cabin ventilation for smoke removal

Normally the pressurization system limits cabin pressurization differential to 9.55 ±0.1 psid. As differential pressure reaches 9.55 psid, an amber CABIN DFRN 9.6 caution message is displayed on the Crew Advisory System (CAS) and the pressurization system begins limiting outflow valve closure.

If the pressurization system malfunctions and cannot limit maximum cabin pressure differential to 9.55 ±0.1 psid, a safety valve limits pressure differential to 9.7 ±0.1 psid. As differential pressure reaches 9.8 psid, a red CABIN DFRN 9.8 warning message is displayed on CAS.

The pressurization system receives information from the two Air Data Computers (ADC #1 and ADC #2). It also uses the Weight-On-Wheels (WOW) system (commonly referred to as the nutcracker system) to control various system operating modes.

Under typical flight conditions, the flight crew programs the system prior to takeoff. Apart from selection of the FLIGHT/LANDING mode switch or adjustment of LFE, system operation is virtually automatic.

Major components of the pressurization system are:

- Cabin Pressurization Transducer
- Cabin Pressure Outflow Valve
- CABIN PRESSURE CONTROL Panel
- Cabin Pressurization Selector Panel
- Cabin Pressure Safety Valve
- Cabin Rate Pressure Switch
- Cabin Pressure Warning Switch
- Cabin Differential Pressure / Altimeter / Rate-of-Climb Indicator

2. Description of Subsystems, Units and Components:

(See Figure 1.)

A. Cabin Pressurization Transducer:

The solid-state cabin pressurization transducer is the heart of the pressurization system. Located in the electronics area of the entrance compartment, produces the output signal to the outflow valve motor based on the following input data:

- Inputs from the cabin pressurization selector panel
- Corrected static pressure data from the ADCs (or Digital Air Data Computers [DADCs])
- FLIGHT or GROUND mode from the nutcracker system
- Sensed cabin pressure from inside the pressure vessel

To prevent undesired outflow valve movement from transient power surges, the transducer obtains a clean, stable supply of power from an Electromagnetic Interference (EMI) filter installed in the radio rack.

Within the transducer are circuits that limit cabin differential pressure in flight to 6,550 feet with an airplane altitude of 45,000 feet.

B. Cabin Pressure Outflow Valve:

A single pressurization outflow valve is installed under the lower shelf of the radio rack. It is an electrically-controlled, motor-driven valve that determines the amount of cabin air exhausted overboard, thus controlling cabin pressurization. It is capable of moving from fully open to fully closed in approximately ten (10) seconds.

The outflow valve is a butterfly type valve with an electro-mechanical actuator and a potentiometer that provides valve position information to the position indicator on the CABIN PRESSURE CONTROL panel. Within the actuator are a DC motor with DC brakes, an AC motor with AC brakes and a motor-generator.

The AC motor, which operates the outflow valve in the Automatic (AUTO) mode, responds to signals from the cabin pressurization transducer. The DC motor operates the outflow valve in the MANUAL mode by responding to signals from the CABIN PRESSURE CONTROL panel manual control knob. Both motors are capable of extremely slow or fast operation, or at any intermediate speed required by the controlling device.

During normal system operation (AUTO mode), the cabin pressurization transducer opens and closes the outflow valve using the AC motor. While the AC motor is in operation, the DC motor brake engages to prevent DC motor movement. The motor-generator in turn provides a rate-of-change signal back to the cabin pressurization transducer.

With the system in MANUAL mode, the manual control knob provides a DC signal to position the outflow valve. The AC motor brake engages to prevent AC motor movement. Although the motor-generator is inactive, the potentiometer still provides valve position information to the valve position indicator.

In the unlikely event that both Essential AC and Essential DC bus power sources are lost, the outflow valve will cease operation and remain at the last position commanded.

C. CABIN PRESSURE CONTROL Panel:

(See Figure 3.)

The CABIN PRESSURE CONTROL panel, located on the cockpit overhead panel, has controls and indicators for:

- Manual control of the outflow valve
- Position of the outflow valve
- Selection of either FLIGHT or LANDING pressurization schedules
- Selection of either AUTO or MANUAL mode of operation
- Selection of either ADC #1 or ADC #2 to supply static pressure information to the pressurization transducer

The cabin pressure control panel operates on 28V DC from the Essential DC bus and 115V AC, 400 Hz from the Essential AC bus.

D. Cabin Pressurization Selector Panel:

(See Figure 4.)

Automatic operation of the pressurization system requires crew inputs on the cabin pressurization selector panel, located on the copilot's flight panel. It contains control knobs and indicator tapes for setting the following:

- FLIGHT: flight plan's maximum aircraft altitude and corresponding cabin altitude to be maintained
- BARO CORR: barometric pressure correction to local conditions (28.00 to 31.00 inches of mercury)
- LDG: preprogrammed LFE (-1,000 to +15,000 feet)
- RATE: cabin altitude rate-of-change for climb and descent in FPM (minimum UP: 50 FPM, minimum DOWN: 30 FPM, maximum UP: 2,000 FPM, maximum DOWN: 2,000 FPM)

Each control knob is connected to a variable resistor and gear train that drives the indicator tape. Once programmed, the cabin pressurization selector panel supplies driving signals to the pressurization transducer.

E. Cabin Pressure Safety Valve:

A pressurization safety valve, located below the radio rack, provides safety pressure relief, vacuum relief and pressurization rate limiting. Because it operates entirely on cabin and ambient pressure, it is independent of all other components in the pressurization system and requires no external power source.

Should the AUTO or MANUAL control mode of the pressurization system malfunction and cabin pressure builds up to approximately 9.7 ±0.1 psid, the safety valve will open. It then modulates to limit cabin pressure to the safety relief pressure of 9.8 psid.

F. Cabin Rate Pressure Switch:

The cabin rate pressure switch functions strictly as a safety device by sensing the rate at which the cabin altitude is increasing (losing pressure). If a failure should occur that results in rapidly rising cabin altitude, the rate switch inhibits automatic (AC) control of the outflow valve and shifts to manual (DC) control. This would occur at loss rates of approximately 3,000 FPM.

G. **Cabin Pressure Warning Switch:**

The cabin pressure warning switch, located on the right side of the entrance compartment, is an aneroid-operated switch that reacts to cabin altitude. If cabin altitude exceeds 9,250 ±750 feet, the switch causes a red CABIN PRESS LOW warning to be displayed on CAS and, if installed, on the Standby Warning Lights Panel (SWLP).

H. **Cabin Differential Pressure / Altimeter / Rate-of-Climb Indicator:**

(See Figure 5.)

The cabin differential pressure / altimeter / rate-of-climb indicator is located on the overhead panel above the CABIN PRESSURE CONTROL panel. It provides the following indications:

(1) Cabin Differential Pressure: The cabin differential pressure indicator (labeled DFRN PRESS) is driven by the cabin pressurization transducer. The display indicates cabin differential pressure to the nearest 1/100th psid on a four digit display.

If cabin differential pressure reaches 9.6 psid, an amber CABIN DFRN-9.6 caution message is displayed on CAS and an amber light above the indicator will illuminate. If differential pressure reaches 9.8 psid, a red CABIN DFRN-9.8 warning message is displayed on CAS and a red light above the indicator will illuminate.

(2) Cabin Altimeter: The cabin altitude indicator (labeled CABIN ALT) is located adjacent to the differential pressure indicator. It displays cabin altitude in feet (FT) on a five digit display.

(3) Cabin Rate-of-Change Indicator: The cabin rate-of-change indicator (labeled RC) is located beneath the cabin altimeter. It displays cabin altitude rate-of-change in FPM on a four digit display. A plus or minus sign precedes the digits to show cabin climb or descent.

3. **Modes of Operation:**

A. **Automatic Operation Mode:**

Automatic operation of the cabin pressurization system can best be understood by using a typical flight scenario shown in Figure 2 as an example. In this scenario, the crew begins their flight with a standard sea level field pressure altitude and progresses through closing the doors, engine start, taxi out, takeoff, climb to cruise, cruise, descent to approach altitude, executing the approach, landing, engine shut down and opening the doors.

The flight crew initially sets 45,000 feet on the FLIGHT scale of the cabin pressurization selector panel. This results in the adjacent CABIN scale reading of 6,550 feet, the isobaric cabin altitude that corresponds to the maximum differential pressure of 9.41 psid. The cabin RATE dial is set at 500 FPM UP, resulting in the adjacent DOWN scale reading 300 FPM. The average rate of climb to 45,000 feet is approximately 2,700 FPM, with a cabin rate of climb of 500 FPM. The departure runway field elevation altitude is then programmed into the LDG (Landing) dial. Destination runway field elevation altitude (4,000 feet in this example) is set during descent. At this point, the pressurization system is programmed for automatic operation and, assuming the AUTO/MANUAL switch is in AUTO, the system will operate in automatic mode when electrical power is applied to the aircraft.

With the airplane on the ground, the AUTO/MANUAL switch in AUTO and the FLIGHT/LANDING switch in LANDING, the outflow valve will cycle open as soon as electrical power is applied. This is due to the absence of airflow and the cabin pressurization transducer sensing an on-ground condition from the nutcracker.

With the main entrance door still open at this point, there is no pressure buildup. A negligible pressure increase (approximately 0.05 psid, equalling pressure drop across the outflow valve) occurs after closing the main entrance door, remaining negligible through engine start, APU shutdown and transfer of air source to the engines. During taxi, the pressure remains low until lineup in preparation for takeoff. At this point, the flight crew selects the FLIGHT position on the FLIGHT/LANDING switch on the CABIN PRESSURE CONTROL panel.

With the FLIGHT position selected, the outflow valve immediately begins to close under rate control, "holding" at approximately 0.25 psid of pressure buildup. This "holding", known as ground differential pressure control, serves to minimize the possibility of "pressure bumps" during takeoff.

As soon as the aircraft becomes airborne, the nutcracker system sends an inflight signal to the cabin pressurization transducer. The transducer in turn commands the outflow valve to close, thus pressurizing the cabin at the programmed rate of 500 FPM UP until the maximum differential pressure of 9.55 ±0.10 psid is reached. The cabin altitude remains stable within ±25 feet of the final cabin altitude, in this case 6,550 feet at an aircraft altitude of 45,000 feet. Stability is maintained provided the aircraft does not climb above 45,000 feet, the maximum allowable altitude of the aircraft.

In preparation for descent, the flight crew enters the destination runway field elevation altitude (4,000 feet in this example) in the LDG window. A discriminator circuit is incorporated within the cabin pressurization transducer to prevent inadvertent programming of an isobaric cabin altitude (CABIN value) lower than the landing field altitude (LDG value). This feature prevents landing with excessive cabin differential pressure. If the discriminator circuit detects a LDG value higher than the CABIN value, it allows the LDG value to override the CABIN value and control that outflow valve. This is the only instance in which the LDG value can override the FLIGHT position on the FLIGHT/LANDING switch while in the AUTO mode. When ready to descend, the FLIGHT/LANDING switch is positioned to LANDING.

Noting that the cabin rate of climb was preprogrammed to be 300 FPM DOWN prior to takeoff, the flight crew adjusts the BARO CORR (barometric correction), if necessary. This completes the descent programming. As the aircraft descends, the system automatically begins to open the outflow valve until a descent rate of 300 FPM is reached. Cabin pressure is maintained at approximately 400 to 500 feet below the actual LFE, or at approximately 0.25 psid.

Upon touchdown, the nutcracker system signals the cabin pressurization transducer of an on-ground condition, causing the outflow valve to be driven fully open. With the outflow valve fully open, cabin pressure drops to a negligible pressure of approximately 0.05 psid until the air supply is shut off.

B. Manual Operation Mode:

To operate the pressurization system manually, the AUTO/MANUAL switch, located on the CABIN PRESSURE CONTROL panel, is selected to MANUAL. This causes the MANUAL switch legend to illuminate amber, the illumination of an amber light (referred to as the motor power indicator) above the AUTO/MANUAL switch and display of an amber CABIN PRES MANUAL caution message on CAS.

The outflow valve may then be controlled by the flight crew, using its DC motor, by means of a knob on the CABIN PRESSURE CONTROL panel. The knob is spring-loaded to return the vertical position, labeled MAN HOLD, when released. Rotating the knob toward OPEN drives the valve open; rotating the knob toward CLOSE drives the valve closed.

The manual control knob circuit is designed such that the further the knob is moved away from MAN HOLD toward OPEN or CLOSE, the more pulses are applied to the motor, i.e., the faster the valve moves in that direction. The amber motor power indicator above the AUTO/MANUAL switch will blink in proportion to the speed of the pulses applied to the motor.

Valve position is shown by an indicator to the right of the control knob. The indicator displays outflow valve position at all times, whether in AUTO or MANUAL modes of operation. When desired valve position is attained, releasing the knob will return the knob to MAN HOLD and the outflow valve will hold (stop) in that position.

To return system to automatic mode, the AUTO/MANUAL switch is selected to AUTO. The annunciations will be extinguished and the MAN HOLD knob function will become inoperative.

NOTE:

On aircraft having ASC 295 incorporated, loss of AC power will automatically switch the pressurization system to MANUAL control. This causes the MANUAL switch legend to illuminate amber, the illumination of an amber motor power indicator above the AUTO/MANUAL switch and display of an amber CABIN PRES MANUAL caution message on CAS.

C. Cabin Pressure Safety Valve Limiting Mode:

Should the AUTO or MANUAL control mode of the pressurization system malfunction and cabin pressure builds up to approximately 9.7 ±0.1 psid, the safety valve will open. It then modulates to limit cabin pressure to the safety relief pressure of 9.8 psid.

D. Depressurization Rate Limiting Mode:

Depressurization rate limiting prevents excessive rates of pressure loss, as might occur, for instance, if a malfunction drives the outflow valve to the full open position. Detection of an excessive rate of pressure loss triggers the cabin rate pressure switch, in turn causing the outflow valve to be driven fully closed and automatic control of the system is inhibited. The MANUAL legend of the AUTO/MANUAL switch illuminates amber and an amber CABIN PRES MANUAL caution message is displayed on CAS.

The flight crew can restore the system to automatic operation after depressurization rate limiting by first hard-selecting the AUTO/MANUAL switch to MANUAL, enabling normal manual control. Reset is then completed by hard-selecting the AUTO/MANUAL switch to AUTO.

E. Pressurization System Check:

The flight crew normally performs the following pressurization system check in the course of their normal procedures:

(1) Ensure the main entrance door is open.

(2) Configure APU BLEED AIR, L ENG BLEED AIR and R ENG BLEED AIR as required.

(3) Select the FLIGHT/LANDING switch to LANDING (green).

(4) Select the AUTO/MANUAL switch to AUTO (green).

(5) Select the ADC #1/ADC #2 switch to ADC #1 (green).

(6) Verify the outflow valve is OPEN on the position indicator. Perform system check as follows:

(7) Select the FLIGHT/LANDING switch to FLIGHT (green).

(8) Verify the outflow valve is driving toward CLOSE. At the midway point:

(9) Select the ADC #1/ADC #2 switch to ADC #2 (amber).

(10) Verify the outflow valve drives fully to CLOSE.

(11) Select the FLIGHT/LANDING switch to LANDING (green).

(12) Verify the outflow valve is driving toward OPEN. At the midway point:

(13) Select the ADC #1/ADC #2 switch to ADC #1 (green).

(14) Verify the outflow valve drives further toward OPEN. Before the valve reaches fully OPEN:

(15) Select the AUTO/MANUAL switch to MANUAL (amber). Verify amber “cabin pressure manual” light illuminates.

(16) Verify manual control of outflow valve to OPEN and CLOSE positions using the manual control knob.

(17) Select the AUTO/MANUAL switch to AUTO (green).

(18) Verify the outflow valve drives fully OPEN if not already fully OPEN. Set final configuration as follows:

(19) Select the FLIGHT/LANDING switch to LANDING (green).

(20) Select the AUTO/MANUAL switch to AUTO (green).

(21) Select the ADC #1/ADC #2 switch to ADC #1 (green).

(22) Verify the outflow valve is OPEN on the position indicator.

(23) Verify amber “cabin pressure manual" light is extinguished.

4. Controls and Indications:

(See Figure 4 and Figure 5.)

A. Circuit Breakers (CBs):

Circuit Breaker Name:	CB Panel:	Location:	Power Source:
CABIN PRESS 115V	PO	D-11	ESS AC Bus, ϕA

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Circuit Breaker Name:	CB Panel:	Location:	Power Source:
CABIN PRESS 28V	PO	B-11	ESS DC Bus
CABIN PRESS IND	PO	A-12	ESS DC Bus

B. Warning (Red) CAS Messages:

CAS Message:	SWLP Indication	Cause or Meaning:
CABIN DFRN-9.8	None	Cabin differential pressure approaching upper limit (9.8).
CABIN PRESSURE LOW	CAB PRESS LOW	Cabin altitude has climbed above limits (9250 ft ±750 ft).

C. Caution (Amber) CAS Messages:

CAS Message:	Cause or Meaning:
CABIN DFRN-9.6	Cabin differential pressure has reached 9.6 psi.
CABIN PRES MANUAL	Cabin pressurization controller has been switched to MANUAL control, either automatically or manually.

D. Other Annunciations:

Indication:	Cause or Meaning:
Amber Cabin Pressure Manual Light	System in MANUAL control mode.
Amber MANUAL Legend On AUTO/ MANUAL Switch	System in MANUAL control mode.
Amber ADC #2 Legend On ADC #1 / ADC #2 Switch	ADC #2 providing static pressure signal to transducer.

5. Limitations:

A. Flight Manual Limitations:

(1) Cabin Pressurization Control System:

(a) Maximum Cabin Pressure Differential Permitted: 9.80 psi

(b) Maximum Cabin Pressure Differential Permitted For Taxi, Takeoff Or Landing: 0.3 psi

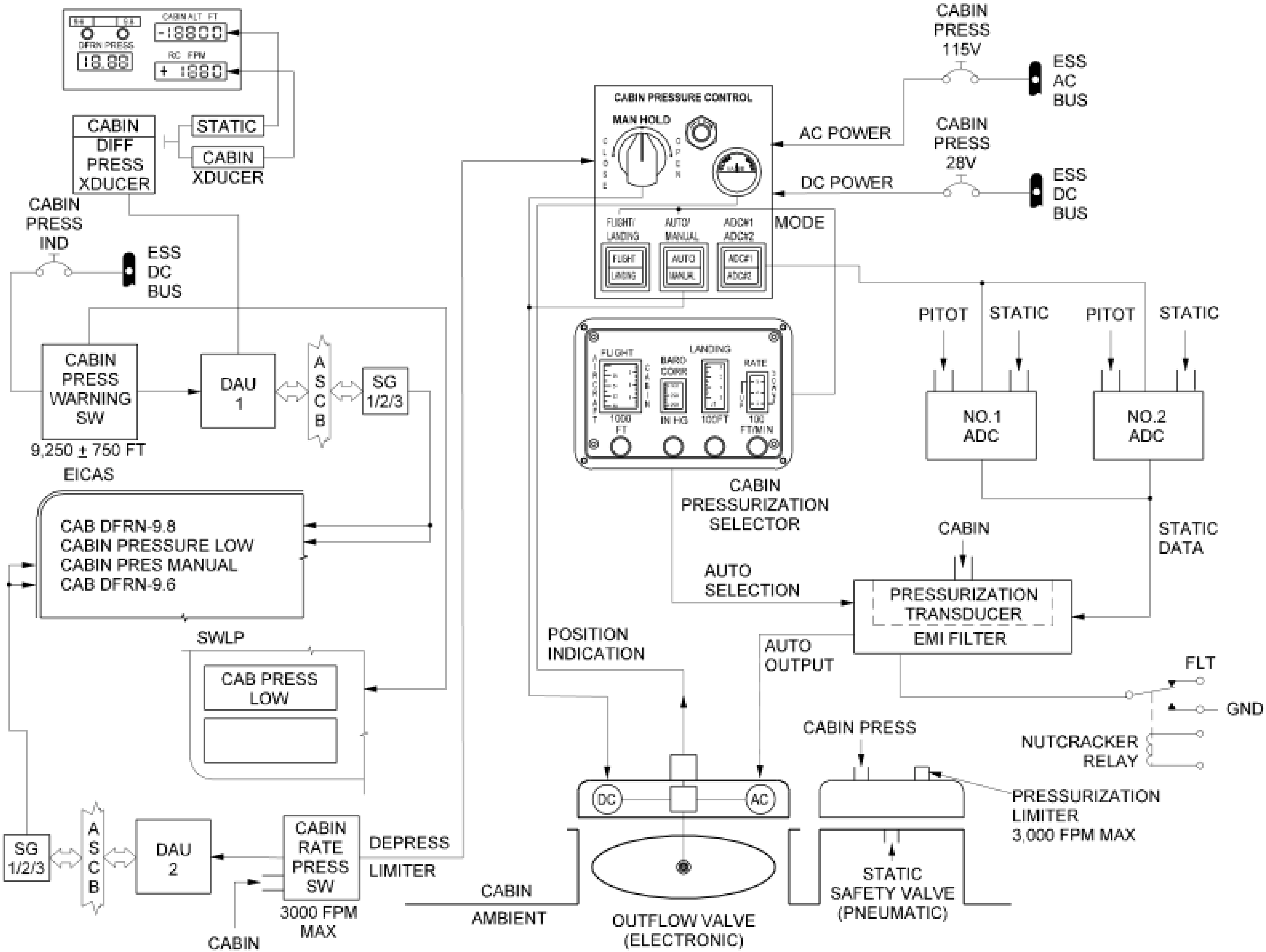
(2) Bleed Air System:

Do not operate above 41,000 ft without both engine bleeds ON and each engine being bled by either the air conditioning system or engine cowl anti-ice. See Section 05-01-10, Air Conditioning System Shut Down Or Inoperative.

B. Operational Data:

Function:	Value:
Normal Maximum Pressure Differential	9.55 ±0.1 psi
Safety Pressure Relief	9.70 ±0.1 psi
Maximum Negative Differential	-0.25 psi
Pressurization Rate Limiting	3,000 FPM
Depressurization Rate Limiting	3,000 FPM

Function:	Value:
Ground Differential Reference Signal	0.5 In Hg
Rate-of-Change Control	±10% of selected value at all cabin altitudes
Barometric Correction Range	28.00 to 31.00 In Hg Absolute Pressure
Cabin Altitude-Isobaric Programming Range	-1000 to 15,000 feet
Landing Altitude Selection Range	-1000 to 15,000 feet
Rate-of-Change Selection Range	Minimum: • 50 FPM UP • 30 FPM DOWN Maximum: • 2000 FPM UP • 2000 FPM DOWN
Rate to Maximum Differential Control Transition	Not to exceed 50 feet with no overshoot beyond the final control value.
Final Absolute Control Pressure	Within 140 feet of selected value at all cabin inflow rates from outflow valve flow of 5 ppm to maximum flow.



Cabin Pressure Control
System Block Diagram
Figure 1

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TYPICAL FLIGHT PLAN

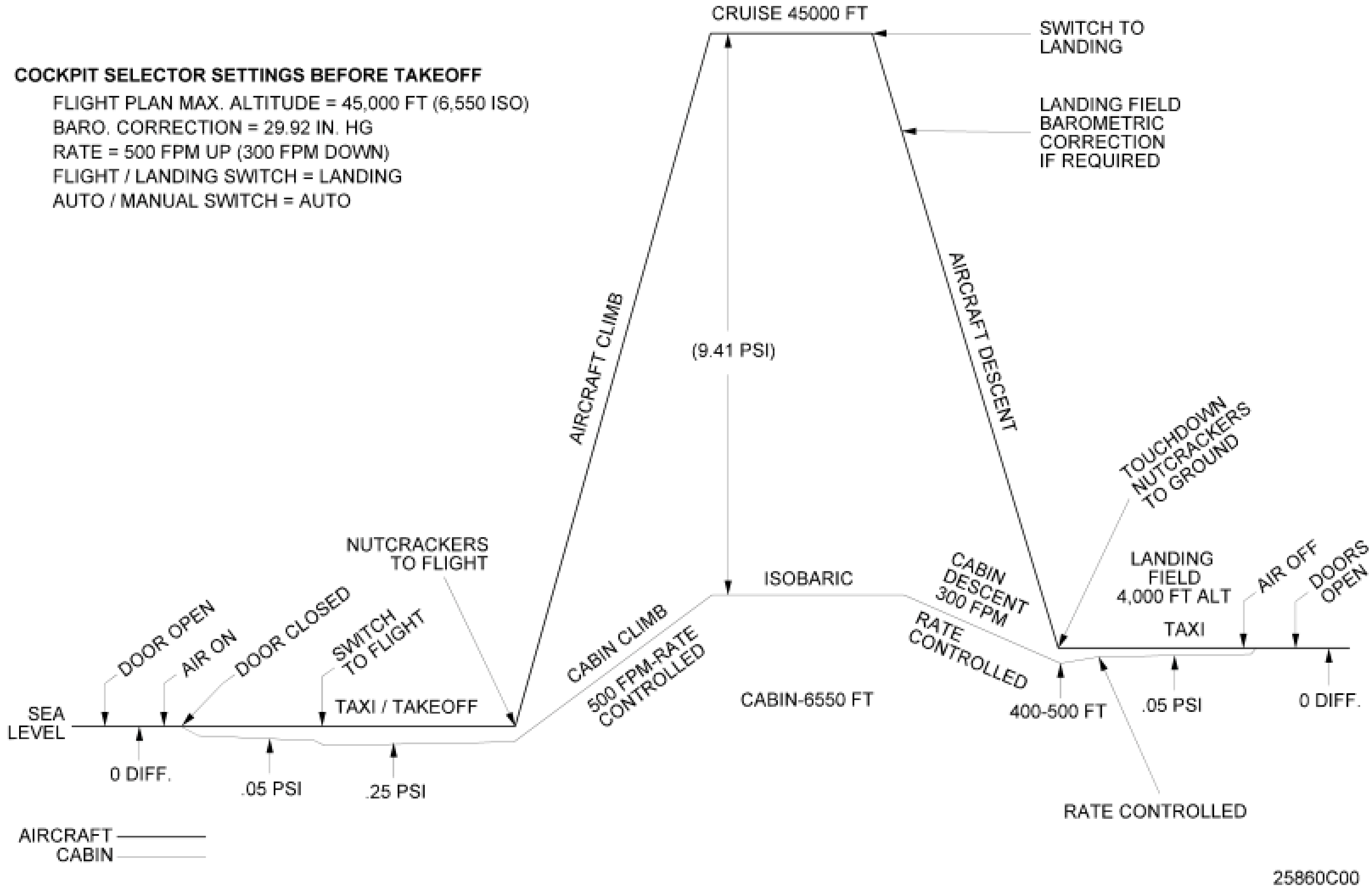
TAKEOFF FIELD = SEA LEVEL ALTITUDE
29.92 IN. HG PRESSURE

CRUISE ALTITUDE = 45,000 FT

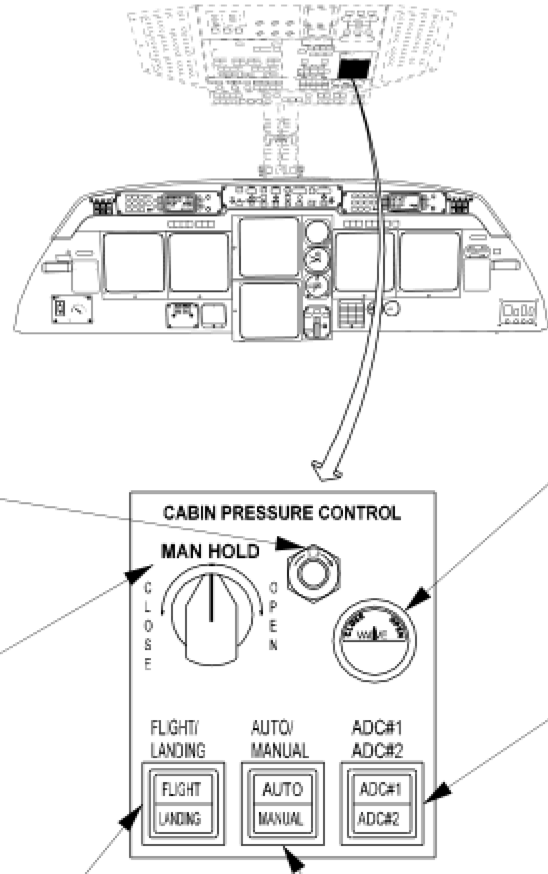
LANDING FIELD = 4,000 FT ALTITUDE

COCKPIT SELECTOR SETTINGS BEFORE TAKEOFF

FLIGHT PLAN MAX. ALTITUDE = 45,000 FT (6,550 ISO)
BARO. CORRECTION = 29.92 IN. HG
RATE = 500 FPM UP (300 FPM DOWN)
FLIGHT / LANDING SWITCH = LANDING
AUTO / MANUAL SWITCH = AUTO



Typical Flight Profile
Figure 2



MOTOR POWER INDICATOR

Illuminates amber to indicate DC power is provided to the outflow valve motor in the MANUAL mode. Flashes proportionate to amount MAN HOLD knob is rotated.

MAN HOLD

In MANUAL mode, provides DC motor control of outflow valve position. Knob is spring-loaded to HOLD. Outflow valve remains in last selected position.

FLIGHT/ LANDING

- Allows selection of pressurization schedule.
- FLIGHT (Green): Closes outflow valve; commences and maintains pressurization schedule.
- LANDING (Green): Opens outflow valve; commences and maintains depressurization schedule.

OUTFLOW VALVE POSITION INDICATOR

- Pointer moves to indicate outflow valve butterfly position.
- Functional in all modes of operation.

ADC #1 / ADC #2

- Allows selection of the ADC to supply static pressure information to the pressurization transducer.
- ADC #1 (Green): Primary ADC.
- ADC #2 (Amber): Alternate ADC.

AUTO/ MANUAL

- Used to select and display pressurization system mode of operation.
- AUTO (Green): Automatic mode; normal mode of operation. Pressurization transducer controls outflow valve.
- MANUAL (Amber): Manual mode of operation has been hard-selected or AC power has been lost (aircraft with ASC 295) or depressurization rate limiting has been initiated. MAN HOLD knob controls outflow valve.

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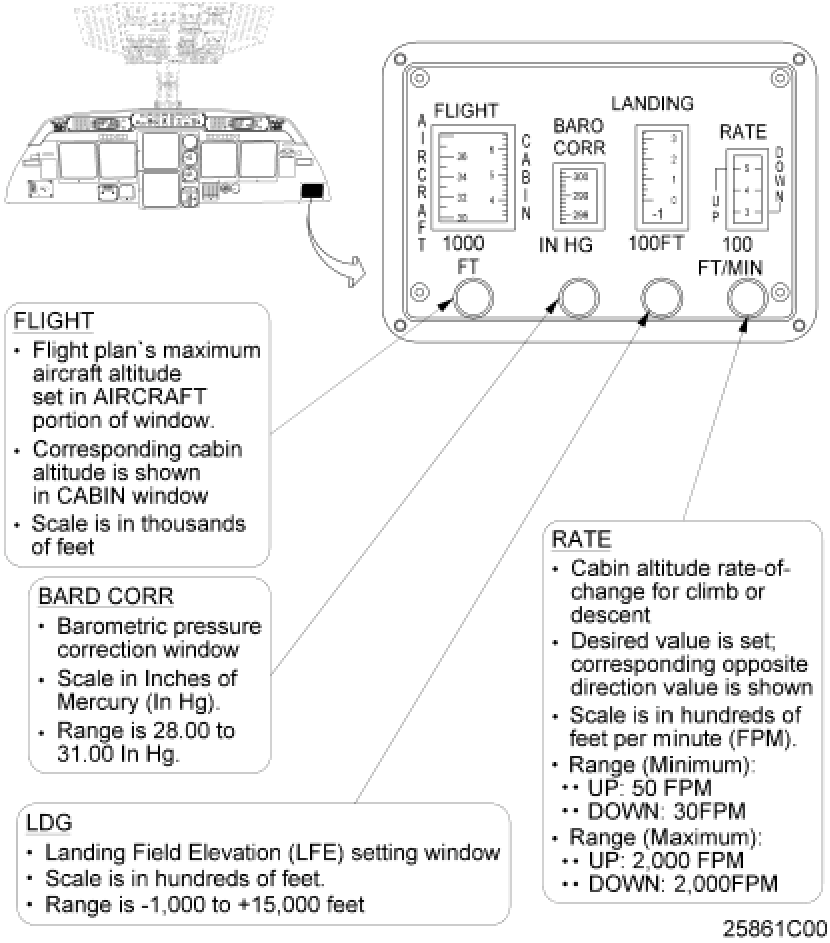
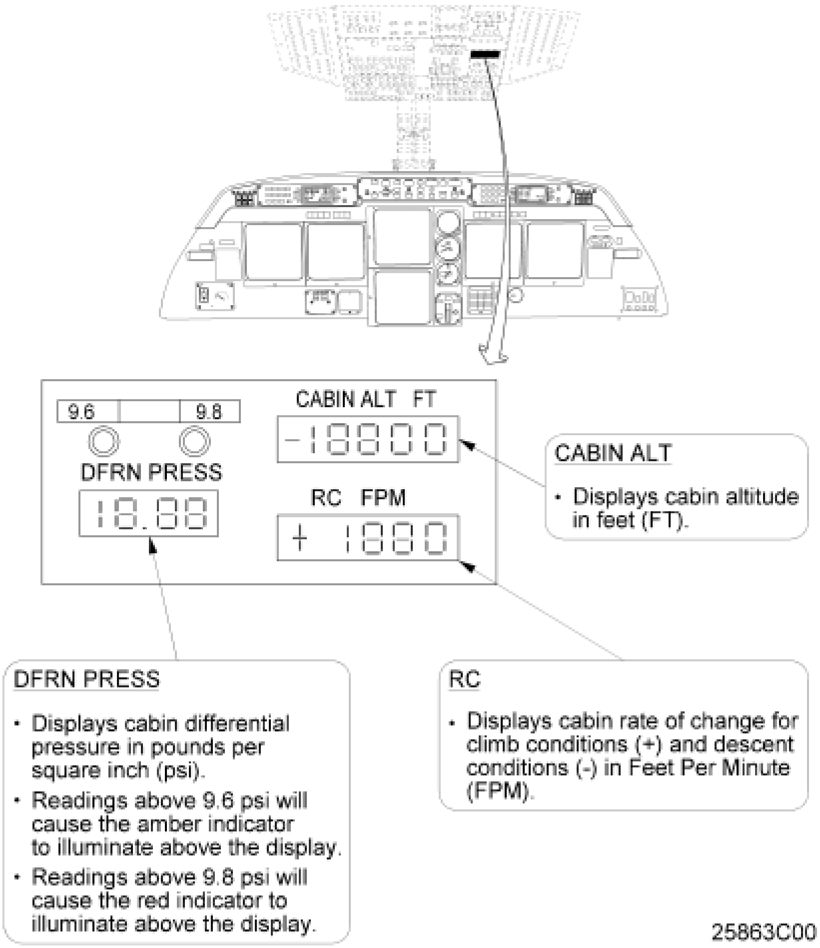
CABIN PRESSURE
CONTROL Panel
Figure 3



Cabin Pressurization Selector Panel
Figure 4



Cabin Differential Pressure / Altimeter / Rate-of-Climb Indicator
Figure 5

2A-21-30: Airflow and Temperature Control System

1. **General Description:**

   The airflow and temperature control system for the Gulfstream IV provides for comfortable cabin and cockpit temperatures throughout the operating envelope of the aircraft by enabling the flight crew to perform the following functions:

   - Select and control bleed air entering and exiting two Environmental Control System (ECS) refrigeration pack assemblies, referred to as the Left and Right ECS Packs. This dual pack concept provides redundancy in the event one pack should fail. Source air into the ECS packs is provided to a bleed air manifold by either an approved external air source or APU air (while on the ground), or by High Pressure (HP) turbine bleed air from either or both of the aircraft's engines (on ground or in flight). Through use of an isolation valve, air from the bleed air manifold can be directed to either ECS pack. This results in a constant mass of conditioned air for all areas within the pressure vessel.

- Control the temperature of conditioned air delivered to the cockpit and cabin areas (referred to as zones) within the pressure vessel. This is done using the two ECS packs to cool incoming air and deliver it to a conditioned air manifold. Valves mix hot bleed air with cold conditioned air to modulate the temperature of the air coming from the manifold into the pressure vessel. Water separation, for humidity reduction, is also provided.

During normal inflight operation, temperature-controlled and pressure-controlled HP bleed air from either or both engines is supplied to the bleed air manifold. Air from the manifold is provided to the ECS packs, where cooling takes place. Each pack consists of a primary heat exchanger, secondary heat exchanger and an air cycle machine (ACM). (The term "air cycle" means that cooling is produced by a thermodynamic cycle, using only air as a medium, as opposed to a vapor cycle, which employs Freon™ or other similar gases.) The ECS packs then reduce air temperature to values above freezing. Humidity reduction is accomplished by a mechanical water separator.

Temperature control of the zones within the pressure vessel is accomplished by varying the amount of hot bleed air which bypasses the cooling equipment. Separate temperature control is provided for the cockpit and cabin zones using a control panel located on the overhead panel in the cockpit. Provisions for manual control of the system are included in the event of a failure rendering electronic control inoperative.

An advantage of the GIV airflow and temperature control system is that it is capable of functioning independently while on the ground. With the engines not operating, the bleed air manifold can be supplied with air from either the APU or from an approved external air cart. System operation on the ground is virtually the same as in flight, the difference being that ram air flow across the heat exchangers is provided by a cooling fan.

Should either or both engines be operating, the flight crew may select either or both engines to supply bleed air to the manifold through use of the ISOLATION valve switch.

During certain emergency procedures, the flight crew may induce ram air ventilation into the airflow and temperature control system. Ram air is supplied from a dorsal fin duct and controlled by a RAM AIR switch located on the overhead panel in the cockpit.

For the purposes of this description, the airflow and temperature control system is divided into the following subsystems:

- Air Control System
- Temperature Control System
- Distribution System
- Refrigeration System
- Ram Air Ventilation System
- Temperature Indication System
- Equipment Cooling System

2. **Description of Subsystems, Units and Components:**

A. **Air Control System:**

(See Figure 6 and Figure 7.)

(1) Bleed Air Manifold:

The bleed air manifold is used as the source of bleed air for the air conditioning system. Air to the manifold is supplied by either an approved external air source or APU air (while on the ground), or by HP turbine bleed air from the aircraft's engines (on ground or in flight).

The bleed air manifold delivers air to using systems, one being the air conditioning system. Delivered air is approximately 400° F at a maximum pressure of 40 psig. For the air conditioning system, air is delivered to the air conditioning shutoff and flow regulating valves in the tail compartment.

(2) Air Conditioning Shutoff and Flow Regulating Valves:

The air conditioning shutoff and flow regulating valves perform two functions in the air conditioning system:

- Act as shutoff valve when system operation is terminated.
- Act as a flow regulator when the system is operating.

The air conditioning shutoff and flow regulating valve is pneumatically operated butterfly valve, using upstream duct pressure as the operating force. An internal electrical solenoid is installed and, when energized, pressurizes the valve to close it. This prevents air entry, ending system operation. When de-energized, upstream duct pressure opens the butterfly valve and airflow starts again. Airflow through the valve is regulated to a maximum of 42.1 (±1.5) pounds per minute (ppm) of flow.

There are several ways to energize the solenoid and close the valve:

- Selection of the RAM AIR switch to RAM.
- Selection of the L PACK or R PACK switch to OFF.
- ACM compressor discharge temperature reaching 450° F (on ground).

For aircraft 1000 through 1155 (excluding 1034) having ASC 135, aircraft 1034, and aircraft 1156 and subsequent, the following additional functions exist:

- Selection of the MASTER CRANK or MASTER START switch closes the LEFT ECS PACK valve (on ground). The valve will automatically reopen when the MASTER CRANK or MASTER START switch is deselected.
- Selection of the L ENG START or R ENG START switch closes the RIGHT ECS PACK valve (on ground). The valve will automatically reopen when the start valve closes.

Exiting the air conditioning shutoff and flow regulating valve, air flows through an ozone filter that reduces concentration to a maximum of 0.1 part per million. The air is then delivered to the temperature control system and split into two paths. One path is routed to the primary heat exchangers (for primary cooling) and the other path is routed to the cabin and cockpit temperature control valves (bypass air).

B. Temperature Control System:

(See Figure 8.)

Air leaving the ozone filter is delivered to the temperature control system and can take two paths: either through the refrigeration unit or through the cabin and cockpit temperature control valves. The amount of air that can pass through the temperature control valves is dependent upon valve butterfly position. The remaining bleed air is delivered to the refrigeration unit to be cooled. This now cold air then rejoins the hot bleed air from the temperature control valves, thereby becoming temperature-controlled (conditioned) air. The position of the temperature control valve determines the compartment temperature by mixing the hot and cold air to maintain the desired temperature. All temperature control devices in this system are directed toward control of the appropriate temperature control valve.

(1) Cabin/Cockpit TEMP CONTROL Panel:

The Cabin/Cockpit TEMP CONTROL panel, located on the cockpit overhead panel, is used to automatically or manually set a desired cabin or cockpit temperature. Each portion of the panel (CABIN and CKPT) is isolated and independent of the other.

The selector knob provides automatic and manual temperature control selection based upon knob position. In the OFF position, no signal is applied to the temperature control valve from either the manual selector knob or the temperature controller. Clockwise rotation of the knob from OFF places the system in the automatic mode of operation (the normal mode of operation), with the temperature controller providing electrical signals to the temperature control valve. Range of the automatic mode of operation is COLD (60° F) to HOT (80° F).

Counterclockwise rotation of the knob from OFF places the system in the manual mode of operation, with the manual selector knob providing electrical signals to the temperature control valve. Range of the manual mode of operation is COLD (temperature control valve fully closed) to HOT (temperature control valve fully open). Returning the knob to OFF defaults the system to full cold operation.

NOTE:

Some aircraft are outfitted with additional manual temperature controls located aft of the baggage compartment door. These controls, however, are pneumatic, not electric and are dependent upon a minimum 3 psid cabin pressure to manipulate the temperature control valves.

(2) Cabin/Cockpit Temperature Control Valves:

The cabin/cockpit temperature control valve is a pneumatic modulating butterfly valve. Pneumatic pressure is required to open the butterfly and the amount of opening is controlled by, and proportional to, the amount of pneumatic pressure applied to an

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internal diaphragm chamber. With no pneumatic pressure applied to the diaphragm chamber, an internal mechanism maintains the butterfly in the closed position.

The pneumatic opening pressure, referred to as servo pressure, originates from pressure ducted from upstream of the valve. The ducted pressure is routed to a servo air pressure regulator and torque motor.

(3) Servo Air Pressure Regulator and Torque Motors:

The servo air pressure regulator and torque motor controls the pressure to the temperature control valve using an electrical signal received from the cabin/cockpit temperature controller. The electrical signal is converted into a pneumatic signal and the pneumatic signal positions the temperature control valve accordingly.

(4) Cabin/Cockpit Temperature Controllers:

The cabin/cockpit temperature controller receives and interprets various inputs in order to derive an output signal. These inputs are:

- Two cabin/cockpit temperature sensors, for ambient temperature
- One cockpit temperature sensor, for ambient temperature
- Two cabin/cockpit duct temperature anticipators, for duct temperature and exhausted air temperature

These inputs are compared to the desired ambient temperature commanded by the TEMP CONTROL panel knob and an output signal is then sent to the servo air pressure regulator and torque motor to position the temperature control valve.

The cabin/cockpit temperature controller receives power from the 28V Right Main DC bus (aircraft 1000 through 1143, excluding 1034) or the Essential DC bus (aircraft 1034, and aircraft 1144 and subsequent).

(5) Cabin/Cockpit Temperature Sensors:

The cabin/cockpit temperature sensors are dual elements consisting of two separate sections. One section provides temperature information to the cabin temperature controllers, while the other element is actually a temperature bulb for the digital cabin air temperature indicator located on the cockpit overhead panel. On airplanes SN 1437 and subsequent and SN 1000 through 1436 having ASC 162A, a second cabin temperature sensor is also installed. It is used for temperature indication only.

(6) Cockpit Temperature Sensor:

The cockpit temperature sensor is a single thermistor sensing element. It is used with the compartment thermostat to provide temperature information to the cockpit temperature controller.

(7) Crossover Function:

Airflow and temperature control capability is maintained in the event of failure of either engine or either ECS pack.

In the event of an engine failure, the BLEED AIR switch for the operative engine is left ON while the BLEED AIR switch for the inoperative engine is selected OFF. The ISOLATION valve would be opened to allow operative engine bleed air to both ECS packs. Both PACK switches are left ON for full airflow and temperature control capability.

In the event of an ECS pack failure, the PACK switch for the operative pack is left ON while the PACK switch for the inoperative pack is selected OFF. The BLEED AIR switch for the operative pack's engine is left ON for full airflow and temperature control capability.

Depending on flight conditions and mission requirements, problem ECS packs should be managed as necessary. Airplane Flight Manual limitations should be consulted if an ECS pack is to be shut down in flight.

NOTE:

Do not select both ECS packs OFF at altitude.

C. Distribution System:

(See Figure 6 and Figure 7.)

Exiting the temperature control valves, the hot bleed air is joined with the cooled air from the refrigeration unit to become temperature-controlled air. This air is then introduced into the cabin and cockpit distribution systems, each having separate temperature control valves and ductwork.

The cockpit distribution system consists of ducting from the cockpit temperature control valve, the refrigerated air duct, an air duct check valve and a silencer. Final distribution is from four outlets in the cockpit: a controllable side (or shoulder) outlet and a non-adjustable foot outlet, for each pilot.

The cabin distribution system consists of ducting from the cabin temperature control valve, a air duct check valve and a silencer. Final distribution is through two louvered baseboard ducts running most of the cabin's length, one on each side.

Cabin and cockpit check valves are installed in the compartment ducting allowing air to flow only in a forward direction. Should the air attempt to reverse flow, the check valve closes to prevent backflow.

Cabin and cockpit silencers are installed in the ducting under the floor to silence air noise from the bleed air ducts.

D. Refrigeration System:

(See Figure 7.)

Bleed air which does not bypass the cabin and cockpit temperature control valves is routed into the refrigeration unit (ECS pack). The ECS pack consists of the following major components:

- Primary Heat Exchanger
- ACM and ACM Overtemperature Thermal Switch
- Secondary Heat Exchanger
- Water Separator System

- Water Separator Anti-Ice System
- Cooling Fan
- Cooling Air Distribution

(1) Primary Heat Exchanger:

The primary heat exchanger is the first stage of the refrigeration process. Ram air from the dorsal fin inlet is used as a coolant. The heat exchanger is a “single pass” type exchanger and is located in the tail compartment.

Air exiting the heat exchanger is split into two ducts. One duct routes air into the eye of the compressor section of the ACM. The other duct routes air through the water separator anti-ice valve into the anti-ice muff assembly, bypassing the ACM and secondary heat exchanger.

(2) Air Cycle Machine (ACM) and ACM Overtemperature Thermal Switch:

The ACM is an expansion turbine which reduces air temperature by causing the air to perform useful work, resulting in lower air pressure and thus, lower air temperature. The work extracted from the airstream in the turbine section is absorbed a compressor wheel directly shafted to the turbine wheel and located in a separate chamber on the upstream side of the unit. A large percentage of the work extracted from the airstream by the turbine wheel is used by the compressor wheel. As the compressor wheel is performing work on the upstream air, its pressure and temperature are increased. This work arrangement is called a pressure recovery system or “bootstrap” system.

With the ACM in full operation (no airflow to the anti-ice valve), airflow moves through the compressor section to the secondary heat exchanger, then to the turbine section nozzle, exiting out the eye of the turbine section into the mixing muff.

A 450° F thermal switch is incorporated into the discharge side of the bootstrap compressor to monitor discharge air temperature. If a malfunction causes low or no airflow across the heat exchangers, the compressor discharge temperature will rise accordingly. At 450° F, the switch causes an amber L-R COOL TURB HOT message to be displayed on CAS. Additionally, when on the ground, the ECS pack will be automatically shut off due to a protection circuit passing through the ground configuration of the nutcracker system.

An amber L-R COOL TURB HOT CAS message in flight may be the result of either an excessive air supply to the ACM, resulting in an overspeed/overtemperature condition, or an air bearing failure in the ACM. Excessive airflow from 12th stage compensation can be the result of operating cowl anti-ice and/or wing anti-ice at high altitudes.

(3) Secondary Heat Exchangers:

Secondary heat exchangers are installed adjacent to the primary heat exchangers. Ram air from the dorsal fin inlet is used as a coolant.

(4) Water Separator System:

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Air expansion inside the cooling turbine and resultant discharge temperatures below ambient forces moisture into the air where it condenses. A two-section water separator provides a means for removing the water.

The first section consists of a coalescer which transforms the many small droplets into a few large drops by forcing the water through a coarse mesh cloth bag. In the second section, the airstream is forced to swirl by means of a series of vanes so that the large drops are spun to the outside walls. Water extracted from the air is also sprayed into the secondary heat exchanger cooling air inlet to assist in cooling.

The water separator is capable of removing approximately 80% of all liquid state water passing through it but it cannot, however, remove water vapor. The water separator also contains a relief valve which, if the coalescer becomes clogged, bypasses the air through the unit. In this case, dehumidification would not take place.

(5) Water Separator Anti-Ice System:

During cool, moist conditions, cooling turbine discharge temperatures can fall low enough that condensed water freezes. To prevent the coalescer from becoming clogged with ice crystals and restricting airflow, a water separator anti-ice system is installed in the tail compartment. The system consists of a water separator anti-ice valve, a sensor and a bypass duct mixing muff assembly.

The water separator anti-ice valve is a butterfly-type shutoff and modulating valve. It controls the refrigeration unit cold air outlet temperature to a minimum of 37° F (nominal) by modulating the flow of compressor inlet air to the anti-ice muff at the turbine discharge. Valve position is controlled by a torque motor in response to signals received from the water separator anti-ice sensor/controller.

The water separator anti-ice sensor/controller is a pneumatic thermostat, installed on the discharge side of the water separator. The thermostat is set to maintain anti-ice valve position so that air moving through the water separator is held at a temperature of approximately 37° F. The sensor/controller remains function throughout all altitude, temperature and humidity ranges.

One cockpit indication that a water separator may be frozen is an absence of cool air in all modes of operation. To determine whether the water separator is merely frozen or the ACM is faulty, the affected PACK switch is selected OFF and a ten minute time period is allowed to elapse. The affected PACK switch is then selected ON and the air temperature is checked. If cool air returns, the water separator was most likely frozen, thus a warmer temperature should be selected. If warm or hot air returns, the ACM is most likely faulty.

(6) Cooling Fan:

Ground cooling places additional requirements on the air conditioning system. As there is no ram air flow, the possibility exists that the air conditioning equipment would overheat unless a source of cooling air is supplied.

A turbofan is installed downstream of the ACM in the dorsal fin ram air duct. The fan assembly provides airflow across the primary and secondary heat exchangers whenever the air conditioning system is in operation on the ground. Fan air leaving the heat exchangers is then exhausted overboard.

(7) Cooling Air Distribution:

Dehumidified, refrigerated air from the discharge side of the water separator is ducted forward, joining that portion of the hot bleed air having passed through the cabin/cockpit temperature control valves to become temperature-controlled air. Also, dehumidified, refrigerated air from the ECS pack is ducted into one line which supplies cabin and cockpit eyeball ducts installed by the operator's completion agency. A check valve is installed in each line to prevent backflow.

E. Ram Air Ventilation System:

In the event of an emergency, the flight crew can ventilate the aircraft with ram air from the ram air dorsal fin inlet. A line is installed in the ram air duct just upstream of the primary heat exchanger. The line is routed to the ram air check valve and then to the downstream side of the left water separator refrigerated air duct. If ram air duct pressure is greater than refrigerated air duct pressure, the ram air check valve opens, allowing ram air into the refrigerated air line. The ram air then moves forward through the cabin duct check valve, into the distribution system.

The ram air check valve allows airflow to move only from the ram air duct into the air conditioning system ducting. During normal operations with the air conditioning system running, system pressure is always greater than ram air pressure, thus the ram air check valve is held closed.

Selection of ram air ventilation is accomplished using the RAM AIR switch located on the cockpit overhead panel. Selection of the switch to RAM supplies 28V Essential DC bus power to close both air conditioning shutoff and flow regulating valves, shutting off the air conditioning system. As air conditioning system duct pressure falls below ram air duct pressure, the ram air check valve opens, allowing ram air into the distribution system. Conversely, selection of the RAM AIR switch to OFF allows both air conditioning shutoff and flow regulating valves to open, restoring the air conditioning system. As air conditioning system duct pressure rises above ram air duct pressure, the ram air check valve closes, allowing air conditioning system air into the distribution system.

NOTE:

Selection of the RAM AIR switch to RAM results in the cabin altitude climbing, eventually causing the pressurization system outflow valve to close. Consideration should be given to manually opening the outflow valve to ensure adequate airflow for radio rack cooling.

NOTE:

During use of ram air ventilation, the flight crew has no control of cabin air pressure or temperature.

F. **Temperature Indication System:**

(See Figure 8.)

A digital cabin/cockpit air temperature indicator is installed on the TEMP CONTROL panel on the cockpit overhead panel. The CABIN temperature display is provided ambient temperature information from the cabin temperature sensor. The CKPT temperature display is provided ambient temperature information from the cockpit temperature sensor. Both sensors also provide temperature information to their respective temperature controller. Location of the sensors is determined by the operator's completion agency.

Power for the indicator is furnished by the 28V Essential DC bus through the CKPT/CABIN TEMP IND circuit breaker. The indicator is calibrated in degrees Fahrenheit, with a maximum display value of 199° F.

G. **Equipment Cooling System:**

(See Figure 9.)

Electric cooling fans are installed to force cooling air to the display unit cathode ray tubes (CRTs), center pedestal equipment, radio racks and nose compartment. With electrical power applied, operation of most fans is automatic and is transparent to the flight crew.

For aircraft 1000 through 1155 (excluding 1034) having ASC 87, and aircraft 1034, 1156 and subsequent, selection of the PILOT, EICAS or COPILOT DISPLAY switch while on the ground energizes both CRT cooling fans. In flight, the fans operate continuously, regardless of switch position.

Supplemental cooling air for center pedestal equipment is provided by a fan mounted in the aft right side of the pedestal. The fan is not thermostatically controlled and operates whenever 28V Right Main DC bus power is available.

With electrical power applied and the main entrance door open, the right-hand radio rack cooling fan operates. On aircraft 1156 and subsequent, a RH RR FAN MAN ON switch is installed on the copilot's side console to provide additional manual control of the right-hand radio rack fan. Additionally, blue RH RR FAN AUTO, RH RR FAN FAIL and LH RR FAN FAIL annunciators are installed on the copilot's side console to show radio rack fan status.

With the aircraft on the ground and nose compartment temperature above 90° F, a thermal switch opens the nose compartment cooling valve. This energizes a fan and illuminates an amber N COOL VALVE OPEN annunciator on each side of the flight panel. Once airborne, a nutcracker relay closes the valve. Should the valve fail to close in flight, the N COOL VALVE OPEN annunciators will illuminate.

3. **Controls and Indications:**

(See Figure 8 and Figure 9.)

A. **Circuit Breakers (CBs):**

The airflow and temperature control system is protected by the following CBs:

Circuit Breaker Name:	CB Panel:	Location:	Power Source:
L AIR COND	PO	C-13	ESS DC Bus
R AIR COND	PO	D-13	ESS DC Bus
CABIN PRESS 115V	PO	D-11	ESS AC Bus, ϕA
CABIN PRESS 28V	PO	B-11	ESS DC Bus
CABIN PRESS IND	PO	A-12	ESS DC Bus
CABIN TEMP CONT	PO	D-14	ESS DC Bus
CKPT/CABIN TEMP IND	PO	A-11	ESS DC Bus
CKPT TEMP CONT	PO	B-13	ESS DC Bus
DISPLAYS FAN #1	CP	D-5	ESS DC Bus (1)
DISPLAYS FAN #2	CP	D-6	R MAIN DC Bus (2)
NOSE COMPT COOL FAN	CP	M-1	R MAIN DC Bus (3)
NOSE COMPT COOL VLV	CP	L-1	R MAIN DC Bus
PED COOL FAN	CP	J-1	R MAIN DC Bus
LH RR COOL FAN	CP	K-1	ESS DC Bus
RH RR FAN CON	CP	I-1	ESS DC Bus
RH RR COOL FAN	CP	H-2	ESS DC Bus
SGL PACK	PO	C-14	ESS DC Bus
L TEMP CONT AC	P	H-11	ESS AC Bus, ϕA
R TEMP CONT AC	P	I-11	ESS AC Bus, ϕA

NOTE(S):

(1) ESS AC bus, ϕA, on aircraft 1000, 1002 through 1095 (excluding 1034) not having ASC 49/49A.

(2) R MAIN AC bus, ϕB, on aircraft 1000, 1002 through 1095 (excluding 1034) not having ASC 49/49A.

(3) R MAIN AC bus, ϕB, on aircraft 1000 and 1002 through 1095, excluding 1034.

B. Caution (Amber) CAS Messages:

CAS Message:	Cause or Meaning:
L-R COOL TURB HOT	Cooling turbine discharge air above 450° F (232° C).
DU FAN 1-2 FAIL	Respective DU cooling fan has failed.
FWD RADIO RACK HOT	Inside radome, left or right equipment bay temperature has exceeded 200° F (93° C).

C. Other Indications:

Indication:	Cause or Meaning:
Amber N COOL VALVE OPEN Annunciator (Pilot's/Copilot's Flight Panel)	Nose compartment cooling valve is open.
Blue LH RR FAN FAIL Annunciator (Copilot's Side Console) **(1)**	Left-hand radio rack cooling fan has failed.
Blue RH RR FAN FAIL Annunciator (Copilot's Side Console) **(1)**	Right-hand radio rack cooling fan has failed.

Indication:	Cause or Meaning:
Blue RH RR FAN AUTO Annunciator (Copilot's Side Console) **(1)**	Right-hand radio rack cooling fan operating automatically.
Blue RH RR FAN MAN ON Annunciator (Copilot's Side Console) **(1)**	Right-hand radio rack cooling fan operating manually.

NOTE(S):

(1) Aircraft 1156 and subsequent.

4. Limitations:

There are no limitations for the airflow and temperature control system at the time of this revision.

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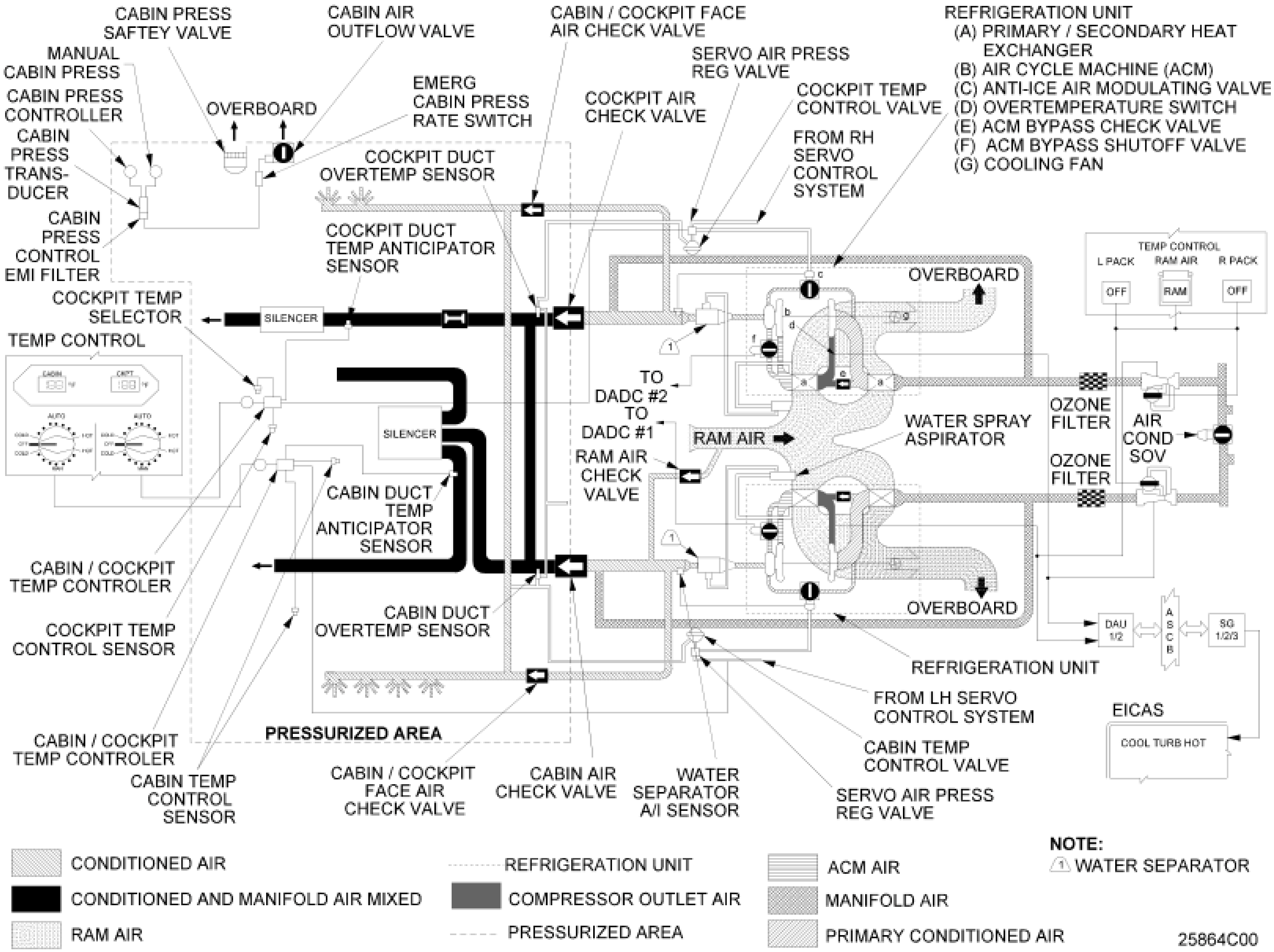
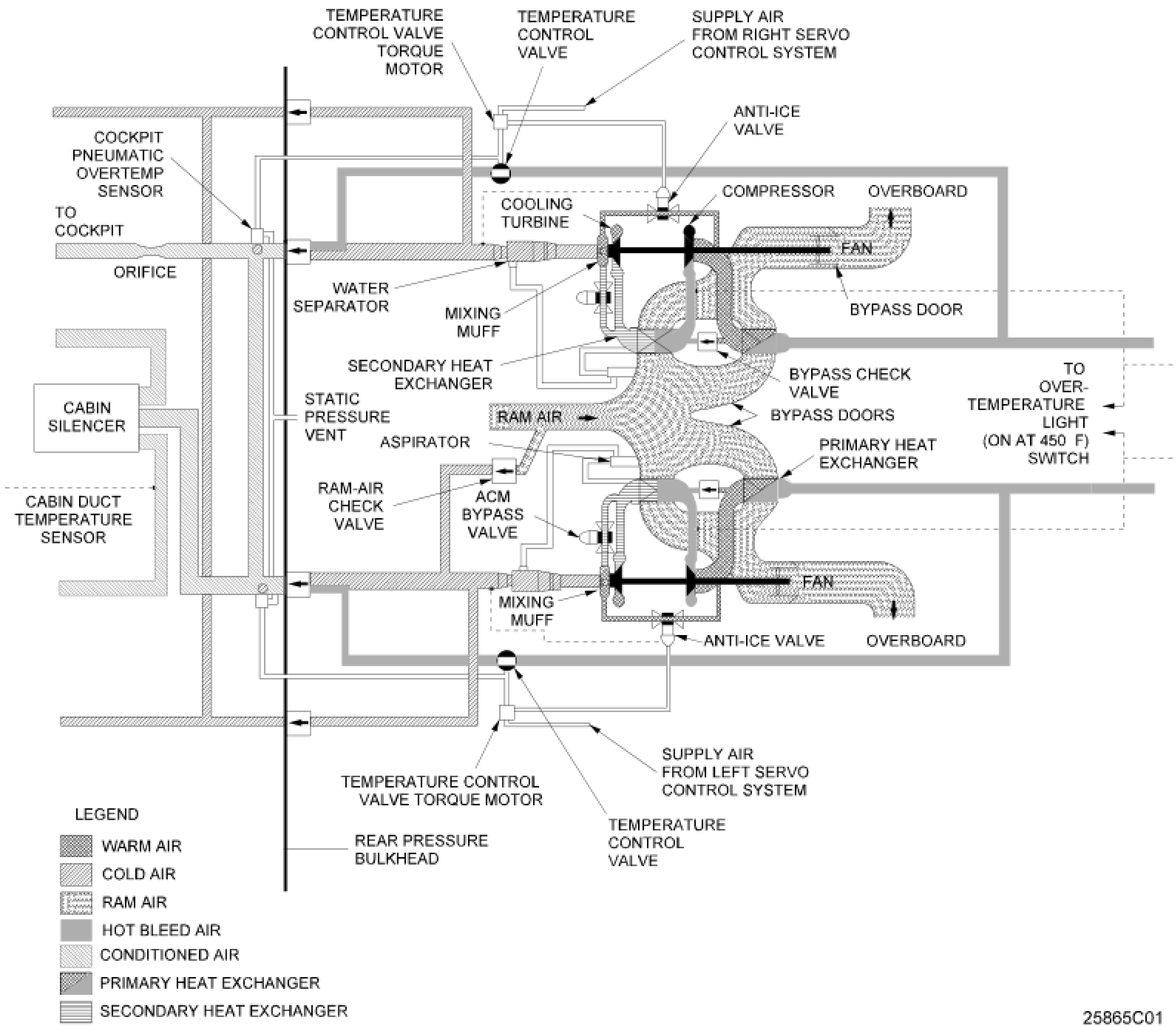


Airflow And Temperature
Control System Block
Diagram
Figure 6



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Refrigeration System
Block Diagram
Figure 7

RAM AIR

- OFF (Normal position, RAM legend distinguished): Ram air is inhibited due to ECS pack airflow.
- RAM (Amber): Both ECS packs are shut off. Ram air from dorsal fin duct enters air conditioning system through ram air check valve.

CABIN / CKPT Temperature

- Display cabin and cockpit temperatures obtained from respective temperature sensor.
- Display in degrees Fahrenheit, with a maximum of 199° F.

CABIN / CKPT AUTO / MAN

- OFF: No signal is sent to respective temperature control valve.
- AUTO: Temperature controller provides signal to temperature control valve. Range is COLD (60° F) to HOT (80° F).
- MAN: Manual selector knob provides signal to temperature control valve. Range is COLD (temperature control valve fully closed) to HOT (temperature control valve fully open).

ISOLATION

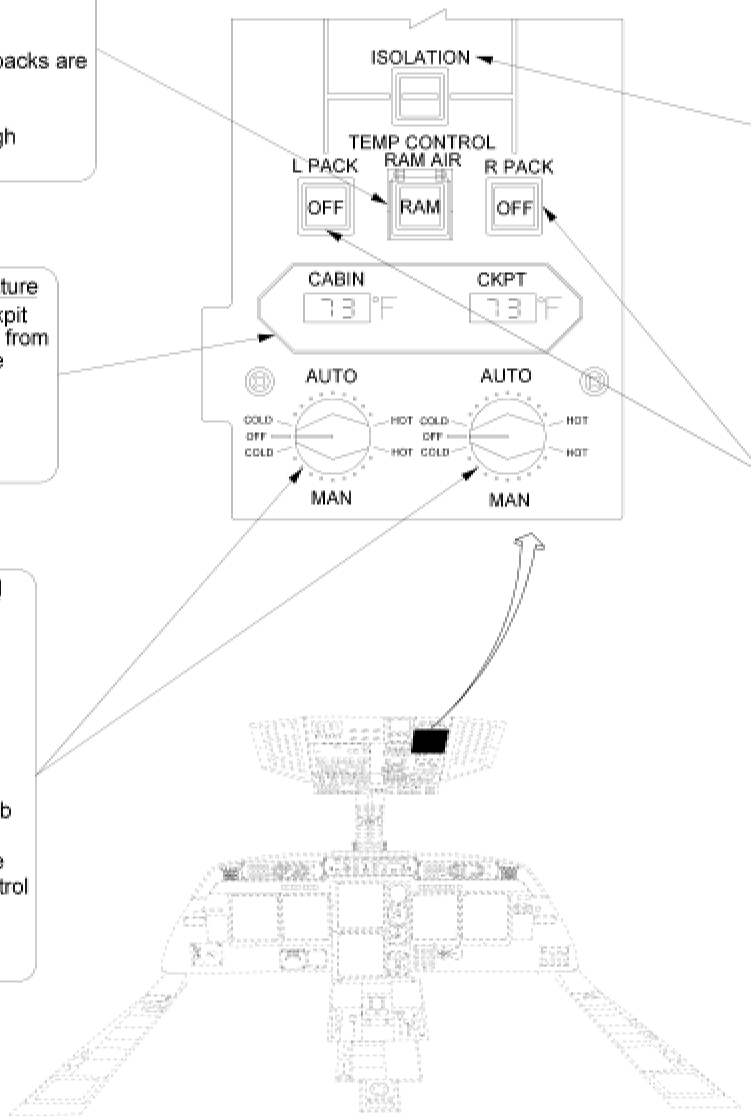
When selected open (on ground):
- White bar in switch capsule illuminates.
- Left and right bleed air manifolds are combined.
- Crossbleed air from opposite engine is available.
- APU air is available for ECS packs and engine starting.

When selected open (in air):
- Same conditions listed above are present except APU air is available for engine starting only.

When selected to OFF:
- White bar in switch capsule extinguishes.
- Left and right bleed air manifolds are isolated.
- Crossbleed air from opposite engine is inhibited.
- APU air is available for R ENG bleed air manifold only.

L PACK / R PACK

- ON (Normal position; OFF legend extinguished): Air conditioning shutoff and flow regulating valve is de-energized, allowing air conditioning air flow.
- OFF (Amber): Air conditioning shutoff and flow regulating valve is energized closed; air conditioning airflow ceases.



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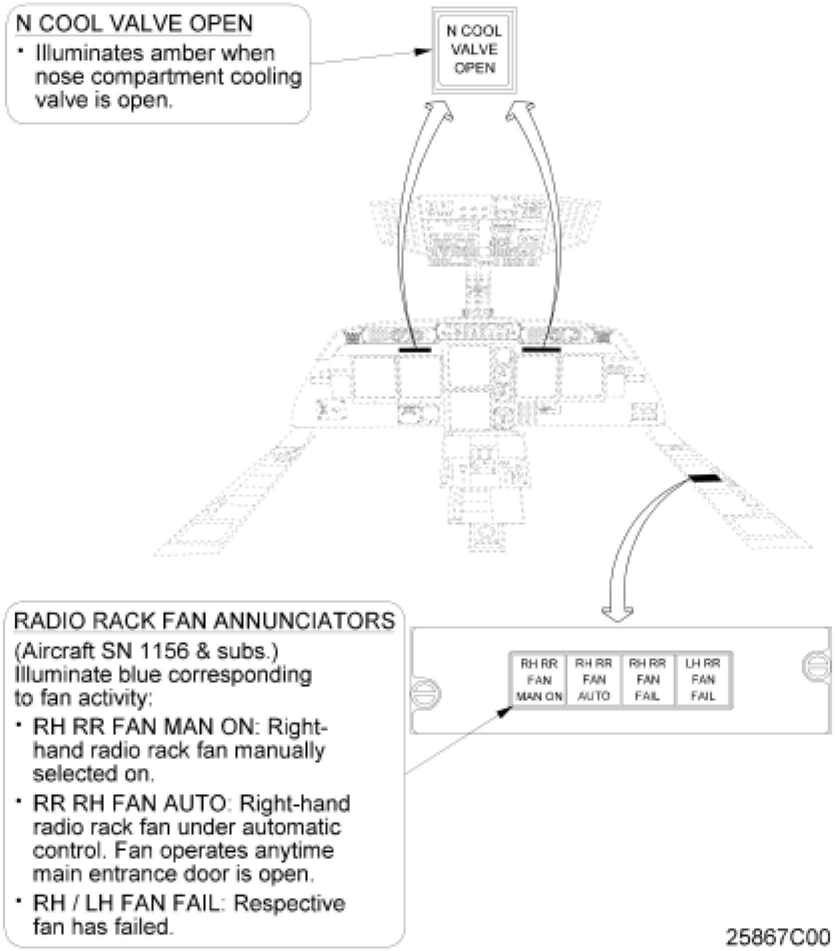
Cabin / Cockpit TEMP CONTROL Panel
Figure 8



Cockpit Annunciators
Figure 9

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