ENVIRONMENTAL

The pressurization and air conditioning systems utilize engine bleed air to pressurize and air condition the cabin and defog the cabin and cockpit windows. During normal operation, most functions are automatic. The only manual adjustments required are for individual comfort, such as fan selection and temperature. If additional cooling is required an optional vapor cycle air conditioning system is available to further cool and circulate the cabin air, which has already been conditioned by the tailcone mounted cabin air heat exchangers and the air cycle machine. A source of rapid cabin cooling is also available in the optional flood cooling system, which can supply a high volume of conditioned air to flood the cabin.

PRESSURIZATION

Two elements are required to provide cabin pressurization. One is a constant source of air. The other is a method of controlling the flow of air into and out of the airplane to achieve the desired differential pressure and resultant cabin altitude. In the Citation II Bravo, the inflow of air to the cabin is constant (through a wide range of engine power settings) and the outflow of air is controlled by the two outflow valves located in the aft pressure bulkhead.

OUTFLOW VALVES

The outflow valves have three modes: ground taxi, pre-pressurization, and flight. In the ground taxi mode the airplane is on the ground with either engine operating below 85% N_2 RPM. Both outflow valves are kept fully open. In pre-pressurization mode when both engines are set to greater than 85% N_2 RPM, both outflow valves will slowly close to bring the cabin altitude to a differential pressure of 200 feet below the field pressure altitude during the takeoff roll. At liftoff the squat switch will put the airplane pressurization system into flight mode. In flight mode the cabin is pressurized by a constant 8 pounds-per-minute of temperature controlled air.

The primary and secondary outflow valves are identical to each other with the exception that the primary valve also has the vacuum ejector, and the cabin altitude climb and dive solenoids mounted on it. These units can function through the secondary outflow valve, if necessary, through connecting ports between the two valves.

The flow rate of the exhausted cabin air is controlled by the modulated position of the diaphragm in the primary and secondary outflow valves. Air can be added to or removed from the control chamber of the valves by the climb and dive solenoids, which respond to commands from the pressurization controller. An increase of pressure in the outflow valve chamber will cause the cabin altitude to decrease; an increase of negative pressure in the control chamber will cause the cabin altitude to climb. If the pressure in each side of the chamber is balanced the cabin pressure will remain static.

In the event that control vacuum should exceed limits due to a malfunction, the cabin altitude limit valves are provided to prevent cabin altitude from exceeding 13,000 feet, +1500 or -1500 feet. If the control vacuum exceeds the barometric reference in the cabin altitude limit valve, it will open and release cabin air into the outflow valve control chamber. This will cause the outflow valves to move toward the closed position and re-establish cabin pressure. The cabin dump switch, located on pressurization-environmental control panel, may be actuated to reduce cabin pressure. The switch disables the electrical controls and activates the primary outflow climb solenoid to pull air out of both outflow valve control chambers and dump cabin pressure to the limits of the cabin altitude limit valve. Complete cabin depressurization will be prevented above an altitude of 14,500 feet.

In the event of a vacuum system failure, the emergency dump valve will be inoperative and cabin pressure will go to maximum differential since vacuum is not available to open the outflow valves. In this case, select pressurization source to MANUAL and control the cabin altitude with the MANUAL UP/DOWN switch.

The maximum differential pressure valve on each outflow valve has an independent pressure relief function which constantly compares cabin pressure to the outside ambient pressure. If it senses a differential pressure of 8.9 psi, +0.1 or -0.1 psi it will vent outflow valve control chamber air to the outside air, allowing the outflow valve to open and prevent excessive cabin pressurization.

PRESSURIZATION SOURCE

Engine bleed air is used as the source of high pressure air to provide cabin pressurization. During normal operations, some of the bleed air passes through the air cycle machine for cooling before entering the cabin.

Each engine has two ports from which compressor discharge air (bleed air) is bled off from the engines. Two control valves, one mounted in each pressurization bleed air line, control the bleed air flow from the respective engine through the air conditioning system and into the cabin. A ground shutoff and pressure regulating valve bypassing the right bleed line, allows bleed air pressure to the air conditioner at a higher flow rate for ground operation.

The emergency pressurization control valve installed on the left bleed air line is used to route orifice controlled bleed air directly to the cabin for emergency pressurization.

The pressurization source selector switch is a six-position switch labeled OFF, GND, LH, NORMAL, RH and EMER. In the OFF position, both bleed air control valves are closed allowing no bleed air to enter the cabin. In the GND position, with the right engine operating, the ground shutoff and pressure regulating valve is open, allowing up to approximately 18 pounds/minute bleed air to flow through the air cycle machine to ventilate the cabin. With this position selected, the BLD AIR GND light on the annunciator panel will illuminate. In the LH position, the left flow control valve will open, allowing the left engine conditioned bleed air (6 pounds/minute) to enter the cabin. In the RH position, the right flow control valve will open, allowing right engine conditioned bleed air (6 pounds/minute) to enter the cabin. In the NORMAL position, the left and right flow control valves will open, allowing both left and right conditioned bleed air (12 pounds/minute) to enter the cabin. In the EMER position, the emergency pressurization valve opens in flight only, allowing hot bleed air from the left engine to enter the cabin directly and the EMER PRESS annunciator light will illuminate. The air cycle machine is bypassed with emergency pressurization selected, cabin temperature will rise, and AUTOMATIC or MANUAL temperature control will be disabled. Cabin temperature can be controlled to some extent with the left throttle. Retarding the left throttle will lower bleed air temperature, but excessive reduction will allow the cabin altitude to climb.

PRESSURIZATION CONTROLLER

The pressurization controller is comprised of two digital windows marked SET ALT and RATE, an FL button, an EXER button and a SET ALT knob. The controller is normally operated in the AUTO mode, which is selected by positioning the MANUAL/AUTO switch on the pressurization-environmental control panel to AUTO. In AUTO mode the operator normally selects the landing field pressure altitude before takeoff by setting the information into the upper window with the SET ALT knob. Then, in flight the controller will continuously

generate an auto-schedule based on the departure field elevation, the maximum altitude in flight sensed by the micro air data computer, and any later operator changes of the landing field pressure altitude. The controller determines the pressure rate of change and the cabin pressure altitude based on the auto-schedule and the air data sensor indicated altitude. The auto-schedule will have the cabin depressurized by an altitude of 1500 feet, + 200 feet or -200 feet, above the set destination field elevation before landing. Cabin rate-of-change is an automatic function of the system and is not directly selectable.

If the air data sensor information is interrupted, or other system failure should cause the AUTO mode to fail, the controller will switch the system to isobaric mode of control. A yellow warning indicator on the display face will illuminate to advise of the change. The landing field altitude on the controller display will then switch to the selected flight level, which will allow the operator to set the desired airplane cruising flight level in order to continue to cause automatic control of the cabin pressure rate of change and the cabin altitude. A near maximum cabin differential pressure will be maintained.

In isobaric control the operator may recall the selected landing field altitude by pressing the FL (flight level) button on the controller, and the selected flight level on the controller display will be replaced by landing field altitude annunciated as CA (cabin altitude). Further pushes of the FL button will cycle the display between flight level (FL) and cabin altitude (CA). Cabin altitude function can be selected to set cabin altitude prior to landing. If air data sensor information is restored the controller will automatically switch back to AUTO mode and the yellow warning indication will be extinguished.

Neither AUTO nor ISOBARIC modes are available in case of DC electrical power failure since the controller does not receive power from the emergency bus. The manual control system functions without electrical power and is used to directly control the outflow valves in case of electrical failure or failure of the automatic controller.

The EXER button on the face of the controller provides two sets of built-in test features - a ground test function and built in maintenance tests. The test is initiated by pressing the EXER button and holding it for approximately two minutes. If the engines are running the cabin will gradually pressurize to 200 feet below field elevation. Releasing the button terminates the test, conducts a display test, and gradually depressurizes the cabin.

The maintenance tests are initiated by pressing a hidden button between the FL and EXER buttons. It requires a slender tool for depression. The airplane must be on the ground to enable the maintenance mode, and once in the mode a yellow warning indicator on the display will continually flash.

AIR CONDITIONING

Air conditioning for the cabin is provided by routing engine bleed air through a precooler in the tailcone and in turn through the air cycle machine which conditions the air prior to distribution to the cabin. Cabin overhead and underfloor ducting is used to distribute the conditioned air. An optional R134A vapor cycle air conditioning system is also available.

The air cycle machine located in the tailcone compartment, cools engine bleed air to approximately 2°C (35°F). Bleed air enters the air cycle machine through any of three bleed air shutoff and pressure regulating valves (LH, RH, GND) and passes over a precooler and heat exchanger. The air is then compressed by a turbine-driven compressor and passed over a second heat exchanger. Finally, the air drives a turbine which extracts energy and

cools the air further. Expansion provides the final cooling. The advantages of the compression cycle are twofold: (1) the compressor section provides a load for the turbine to work against and (2) compressing and heating the air increases the efficiency of the second heat exchanger. Fresh air enters the tailcone through the flush scoops in the dorsal fin. A small fan, driven by the air cycle machine, pulls the fresh air over both heat exchangers and the precooler and dumps it overboard through a vent in the tailcone.

To warm the cabin to a desirable temperature, a bypass valve allows some hot engine bleed air to bypass the ACM and mix with the cold air exhausted from the air cycle machine. The bypass valve is controlled by the automatic or manual temperature control located on the pressurization environmental control panel. With the temperature control selector in the MANUAL position, the bypass valve can be controlled manually by the MANUAL HOT/MANUAL COLD switch. The switch has three positions, spring-loaded to the center (OFF) position. When the switch is deflected toward the MANUAL HOT position, the bypass valve is driven open, allowing more hot bleed air to bypass the ACM and mix with the cold air exhausted from the air cycle machine. When the switch is released, the bypass valve will remain at that position. When the switch is moved toward the MANUAL COLD position, the bypass valve is driven closed. The bypass valve, when manually controlled, will travel from full open to full closed in approximately ten seconds. When AUTOMATIC temperature control is selected, the cabin temperature will be automatically controlled, corresponding to the position of the automatic temperature selector. Response rate in automatic depends on temperature conditions. Two air duct temperature sensors are linked to the automatic temperature control selector to drive the bypass valve towards the desired position. Should the duct temperature become excessively hot, the amber AIR DUCT O'HEAT annunciator panel light will illuminate. This is an advisory light and corrective action, lowering the cabin temperature, should be accomplished to prevent system damage.

An air conditioning overheat sensor is installed between the compressor and turbine section of the air cycle machine to prevent excessively hot air from causing damage to the air cycle machine due to overheating. If this sensor indicates that the compressor section is producing air that is too hot (approximately 435°F), it will close all shutoff valves in the bleed air ducts and open the emergency pressurization valve when airplane is in flight. This will secure the air cycle machine and pressurize the cabin by the emergency method. This condition will be indicated by the illumination of the EMERG PRESS ON annunciator light as well as the increased noise level associated with high velocity air entering the cabin. If the temperature drops below approximately 405°F within 12 seconds, the system will automatically return to normal operation. If the temperature is not reduced within 12 seconds, it will be necessary to rotate the pressurization source selector knob in the cockpit to EMER position and then reselect LH, RH, or NORM to reset the system for normal operation.

An ACM O'PRESS annunciator on the annunciator panel illuminates to warn that the air cycle machine pressure is in excess of 42 PSI. Normally, for the ACM pressure to become this high, the ground control valve must be open. Activation of an over-pressure condition causes the secondary bleed air pressure control switch to activate and close the ground control valve, which is located in the tailcone. If the ground valve has closed, it will cause the BLD AIR GND light to extinguish. Therefore, if the ACM O'PRESS light illuminates and the BLD AIR GND light is still illuminated, the ground control valve has probably failed open. This unlikely event also would require the failure of the primary bleed air pressure control switch.

PRESSURIZATION CONTROL SYSTEM SCHEMATIC

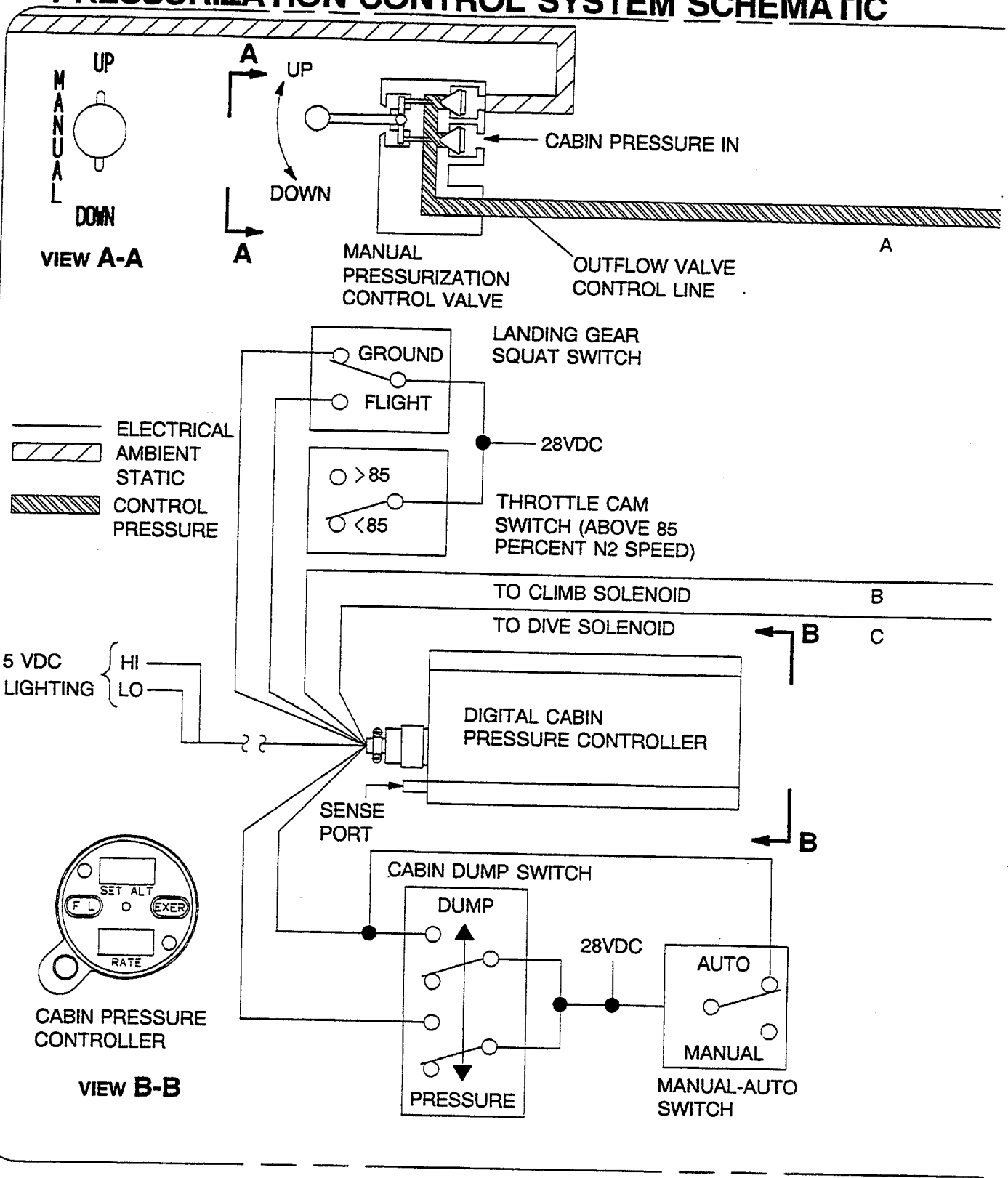


Figure 2-24 (Sheet 1 of 2)

6385C2013 (L)

PRESSURIZATION CONTROL SYSTEM SCHEMATIC

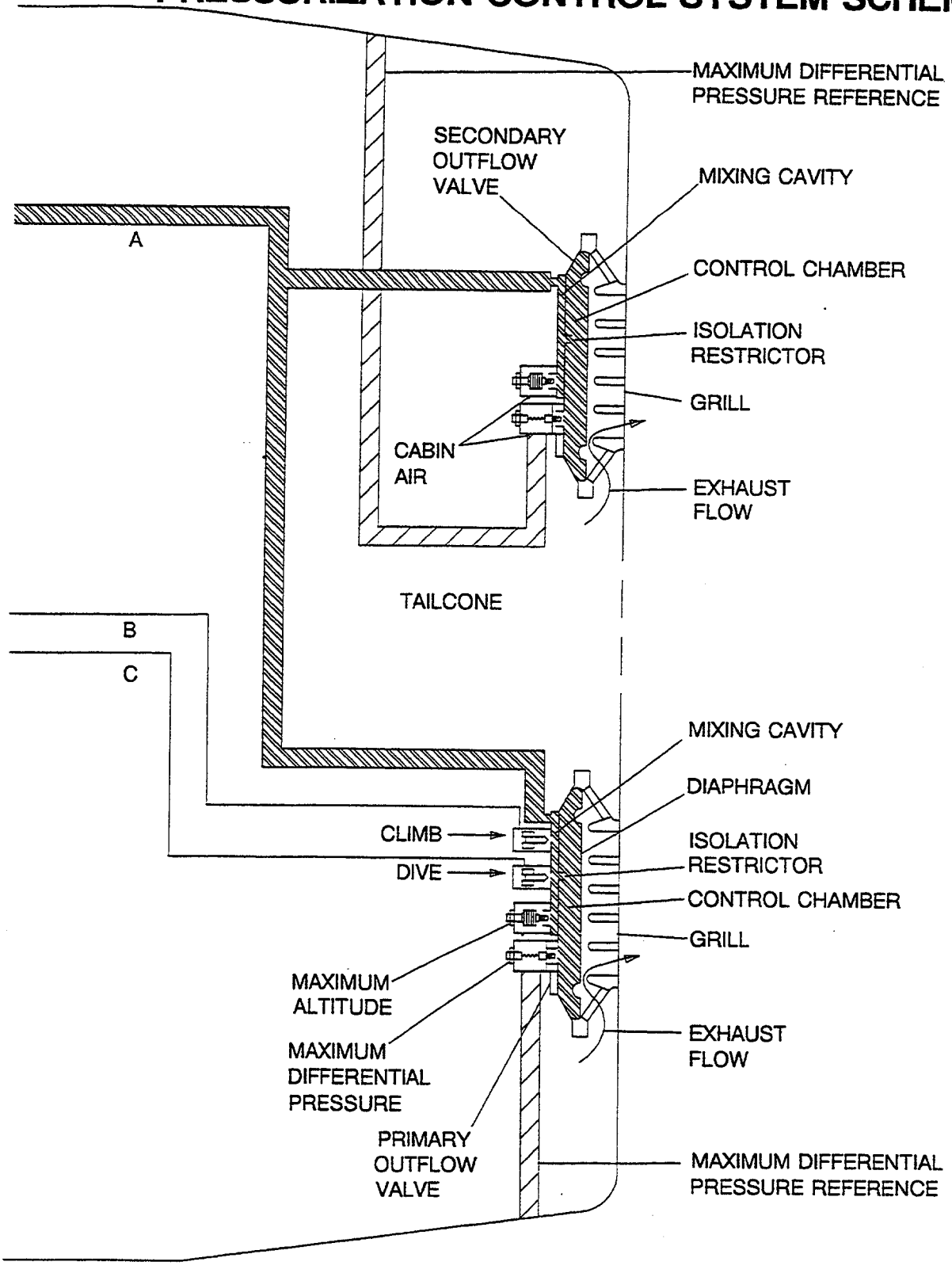
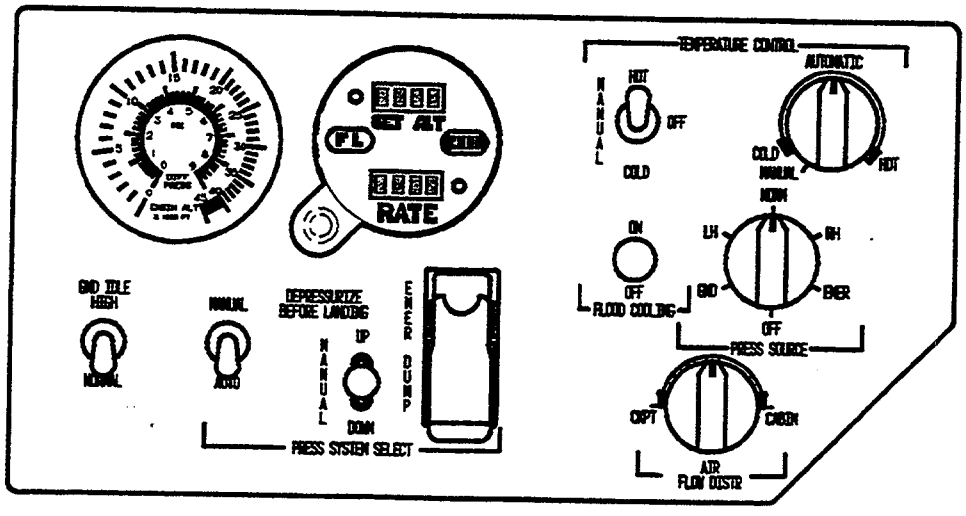


Figure 2-24 (Sheet 2 of 2)

6385C2013 (R)

PRESSURIZATION - ENVIRONMENTAL CONTROL PANEL (TYPICAL)



6515C010

Figure 2-25

During high altitude operation, particularly at low airspeed and high power settings while attempting to cool a warm cabin, it is possible for the cooling demand to exceed air cycle machine (ACM) capabilities. This would result in ACM overtemperature and shutdown and automatically trip the EMERGENCY pressurization on. To preclude this, an overtemperature protection circuit is incorporated which will bias the temperature controller when the ACM compressor discharge temperature reaches approximately 405°F. This bias causes the ACM temperature controller to respond as if a warmer cabin temperature had been selected; therefore, it switches from cooling to heating mode until the ACM overtemperature condition is corrected. Once the ACM compressor discharge temperature has cooled, the bias is automatically switched out and the ACM will return to cooling mode. This system will cycle the bias in and out until the ACM stabilizes (cabin temperature reaches selected value). The ACM overtemperature protection circuit operates only in the AUTOMATIC temperature controller mode. Therefore, operations above 31,000 feet altitude should be restricted to AUTOMATIC mode. It is possible, at high altitude, when using MANUAL mode, to select a cold enough temperature to cause ACM shutdown and to trip the emergency pressurization on.

A water separator is provided to dehumidify the conditioned air before entering the cabin. The conditioned air enters the water separator where it is filtered and the excess water is removed. The conditioned air is then ducted through a check valve into the cabin flow ducts for distribution. The condensate is injected into the air flowing over the heat exchangers to increase cooling.

The cabin air distribution system consists of an overhead air duct and outlets, and underfloor and armrest air ducts which supply conditioned air to the footwarmer manifolds, armrests, and the overhead outlets. A separate cockpit and defog air distribution system is ducted forward through the underfloor from a defog blower in the aft cabin.

When the air temperature selected is cold, a damper valve directs the air through the overhead, floor and armrest air ducts. As the temperature selected becomes warmer, the damper valve will close, recirculating underfloor airflow through the overhead air duct. When a hot temperature is selected (over 38°C (100°F), the damper valve will be closed, which directs all hot airflow through the floor and armrest air ducts.

A flow divider is provided to allow the crew to proportion, to a certain extent, the amount of air provided to the cockpit versus the cabin. The flow divider does not affect the overhead outlet system. A five-position selector is provided on the tilt panel for control of the flow divider.

Switches labeled OVHD FAN and DEFOG FAN are located on the copilot's panel. Both have HI/OFF/LOW positions. If increased air circulation is desired, position the OVHD FAN switch to the HI or LOW position. This actuates the cabin fan, increasing airflow through the overhead ducts. The DEFOG FAN switch controls defog and ventilation airflow into the flight compartment.

BLEED AIR SYSTEM SCHEMATIC

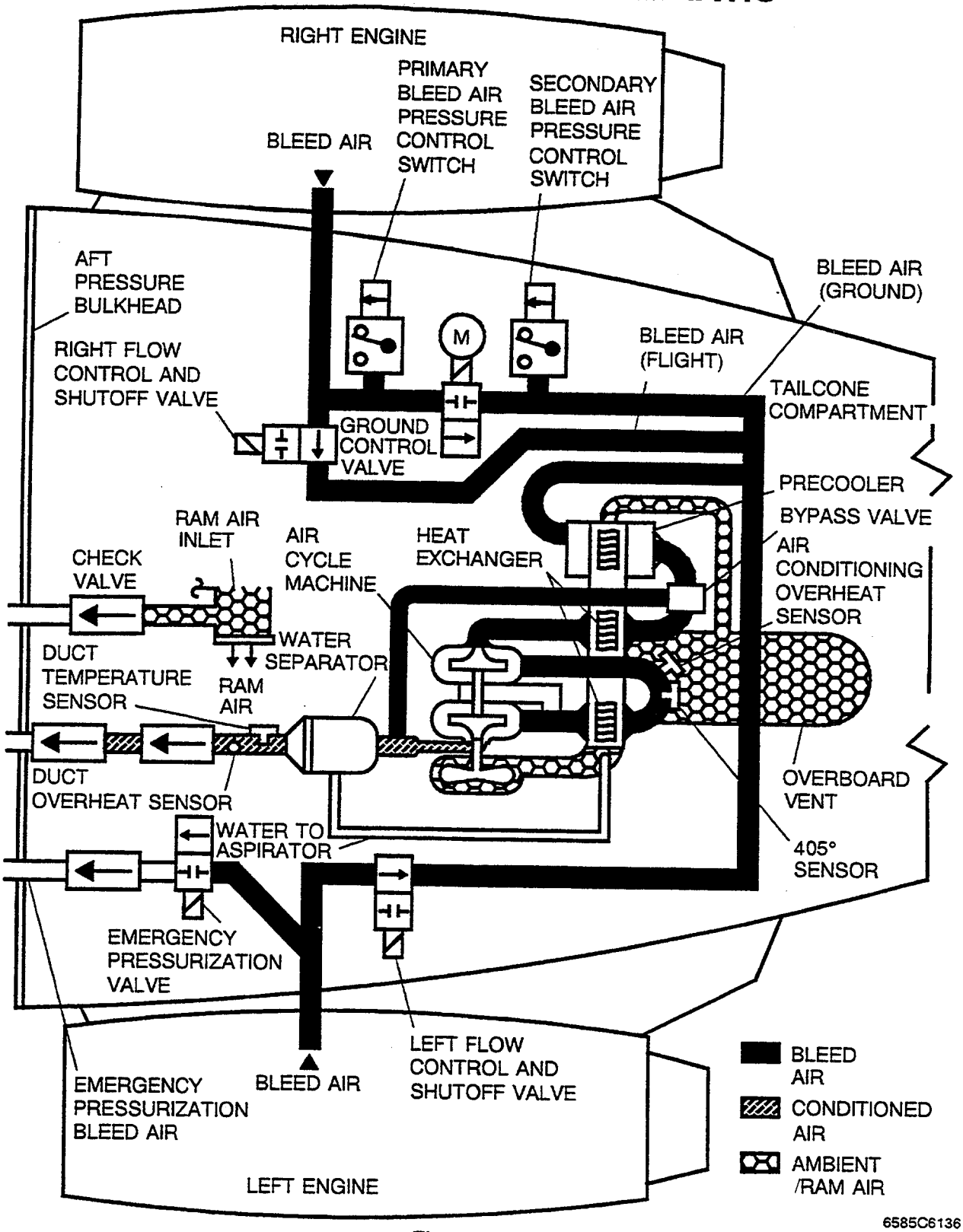


Figure 2-26

VAPOR CYCLE AIR CONDITIONING (OPTIONAL)

An optional factory installed vapor cycle air conditioner using R134A refrigerant is available. It discharges conditioned air from floor mounted evaporator/blowers in the forward and aft ends of the dropped isle, to provide rapid cabin cooling. The air conditioner is controlled by a switch panel on the copilot's instrument panel, and can be used on the ground or in flight up to 18,000 feet. The MODE, AC/FAN/OFF switch controls primary power to the system. The AC position turns on the compressor and the forward blower. The FWD FAN HI/LO switch controls the forward blower speed when the MODE switch is in AC or FAN. A COMP ON twist-dimmable light illuminates when the compressor is powered. The system may not be operated in the AC mode above 18,000 feet. A ground unit, or at least one generator, must be on line to run the compressor.

FLOOD COOLING SYSTEM (OPTIONAL)

The Flood Cooling System provides an air outlet grill on the upper aft pressure bulkhead to supply a high-volume flow of conditioned bleed air to flood the cabin, for faster and more efficient cooling. The system is controlled by an ON-OFF switch on the environmental control panel. When the switch is in the ON position, conditioned bleed air is diverted through a line in the tailcone to an axial flow blower on the top of the aft pressure bulkhead, then to the air outlet grill. The system can be used during ground operation and in flight below 10,000 feet. Use of the system above 10,000 feet pressure altitude and/or use for cabin heating are both prohibited due to temperature and pressure limitations of the tailcone duct. Dual check valves in the duct ensure against reverse flow when the system is not in use. Installation of the flood cooling system is compatible with the installation of a vapor cycle air conditioning system.