PRESSURIZATION/ENVIRONMENTAL SYSTEM

GENERAL

Normal cabin pressurization is generated by distributing engine bleed air, conditioned through the environmental control units, into the cabin and cockpit areas. The degree of pressurization (cabin altitude) is determined by the amount of pressurization air permitted to escape through the outflow valves. The Citation X baggage compartment is pressurized and heated through an isolation valve between the two compartments.

The system is so designed that if environmental conditioning units (ECUs) are selected ON while the airplane is on the ground, such as for cockpit and cabin cooling, high pressure fourteenth stage (HP) bleed air will be automatically selected, in order to provide adequate air for operation of the ECUs. If the throttle lever angle (TLA) is advanced past approximately 30 degrees, low pressure air will be better suited for that condition, so system logic will cause a change over to eighth stage low pressure air for the air conditioning system. In flight air for the ECUs will normally be provided by the low pressure section of the engines. If the throttle lever angle is below approximately 29 degrees in flight, high pressure air will be provided. In the approach mode, however, with the landing gear down, only low pressure air will be selected by the system. Due to the differing requirements of the air conditioning system and the anti-ice systems, air from different sections of the pneumatic system is selected automatically at various times in the flight envelope.

Air is also bled off the compressor section of the auxiliary power unit (APU), gas turbine engine, to be used for the starting of the airplane engines, for service air to pressurize the cabin and baggage door seals, to operate the vacuum ejector jet, etc., and for cabin and cockpit air conditioning, usually when the airplane is on the ground.

PRESSURIZATION

Two elements are required for cabin pressurization. One is a constant inflow of air, the other is a method of controlling the flow of air into and out of the airplane in order to achieve the desired differential pressure and resultant cabin altitude. In the Citation X 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 two outflow valves located in the aft cabin lavatory area.

PRESSURIZATION SOURCE

Each engine has high pressure (fourteenth stage) and low pressure (eighth stage) ports from which compressor discharge air is bled off from the engines. Valves in each pressurization line control the bleed air flow from the respective engine through the environmental control unit and into the cabin and cockpit area for heating, cooling, and cabin pressurization.

CABIN PRESSURE CONTROL SYSTEM

The cabin pressure control system consists of a manual control valve and a selector mounted on the PRESSURIZATION control panel on the right tilt panel, a remote mounted digital controller, and two outflow valves mounted low on the left and right cabin skin, in the aft cabin lavatory area.

Two types of automatic pressurization control are normally available to maintain cabin altitude; an automatic schedule type operation (NORM) and a cabin altitude selection type (ALT SEL). Either type of operation may be selected by positioning the ALT SEL/NORM switch on the PRESSURIZATION control panel to the appropriate position. In the normal (NORM) position, the controller will follow an automatically scheduled mode. The cabin versus airplane altitude schedule is programmed into the electronics, and logic is added to automatically perform all the inflight decisions normally required by the crew. In the ALT SEL mode the operator selects the cabin altitude at which the system will govern, and the rate of change at which the cabin altitude will be established and maintained. A "pip" mark on the rate selector provides cabin altitude rate changes of approximately 500 feet per minute up and 300 down. In the NORM mode of operation, the setting on the automatic rate selector will act as a maximum and the automatic logic built into the system may not require the rate-of-change setting selected in the knob.

In the automatic modes (NORM and ALT SEL) the controller drives the primary outflow valve by modulating the electro-pneumatic transfer valve (an integral part of the primary outflow valve), and the secondary valve follows the primary by virtue of the valve interconnect line. The primary outflow valve's vacuum supply is provided by the air ejector, which is mounted in the left side of the tailcone, and is driven by the service air system, which operates on bleed air from one or both engines. A fully pneumatic backup manual control system is provided in case of electrical failure and is active when power is removed from the system by interruption of electrical power or by the selection of manual cabin pressure control. Manual control can be selected by the operator by placing the MANUAL/NORM switch in the MANUAL position, which causes the outflow valves to be pneumatically controlled by the manual control valve. Each outflow valve has an altitude limit control valve that prevents the outflow valves that limit maximum cabin altitude to approximately 14,250 feet MSL±750 feet. Each outflow valve also has a pneumatic cabin-to-atmosphere differential pressure limiting mechanism that causes the outflow valves to relieve any pressure in excess of 9.5 PSI differential, in addition to a delta pressure relief built into the electronic controller limiting pressure to 9.3 PSI differential.

In the altitude select (ALT SEL) mode of operation, the operator selects the cabin altitude, and the cabin altitude rate-of-change. Before landing, the operator verifies and/or selects a cabin altitude equal to landing field elevation (to land at minimum differential pressure). The landing altimeter setting, which has been entered into the micro air data computers, is then used by the pressurization controller to provide the correct pressure altitude for the pressurization system, according to the field pressure altitude and the field elevation.

The automatic schedule (NORM) mode uses a fixed schedule of cabin altitude versus airplane altitude as a nucleus for completely automatic regulation of cabin pressure while the airplane is in flight. The operator selects the landing field elevation before flight; when the landing field barometric pressure is set into the altimeters prior to landing the data is provided to the pressurization controller, which uses it to compute a cabin altitude for landing. As the airplane lands and the landing gear switch goes to the weight on wheels position, the system enters the landing mode. The system then takes the cabin pressure to field elevation at the selected rate for one minute. After one minute, the system enters the ground mode (at least one WOW switch signaling on-ground and both throttles below 70% N_1) and calls for minimum differential pressure by driving both outflow valves full open. If, upon landing, the cabin altitude is below the actual field altitude, the system will automatically raise the cabin altitude at a rate of 500 feet per minute for one minute or until the cabin becomes unpressurized. At the end of one minute it will then enter the ground mode and dump any remaining cabin pressure at a rate of 2000 feet per minute.

PRESSURIZATION CONTROL SYSTEM

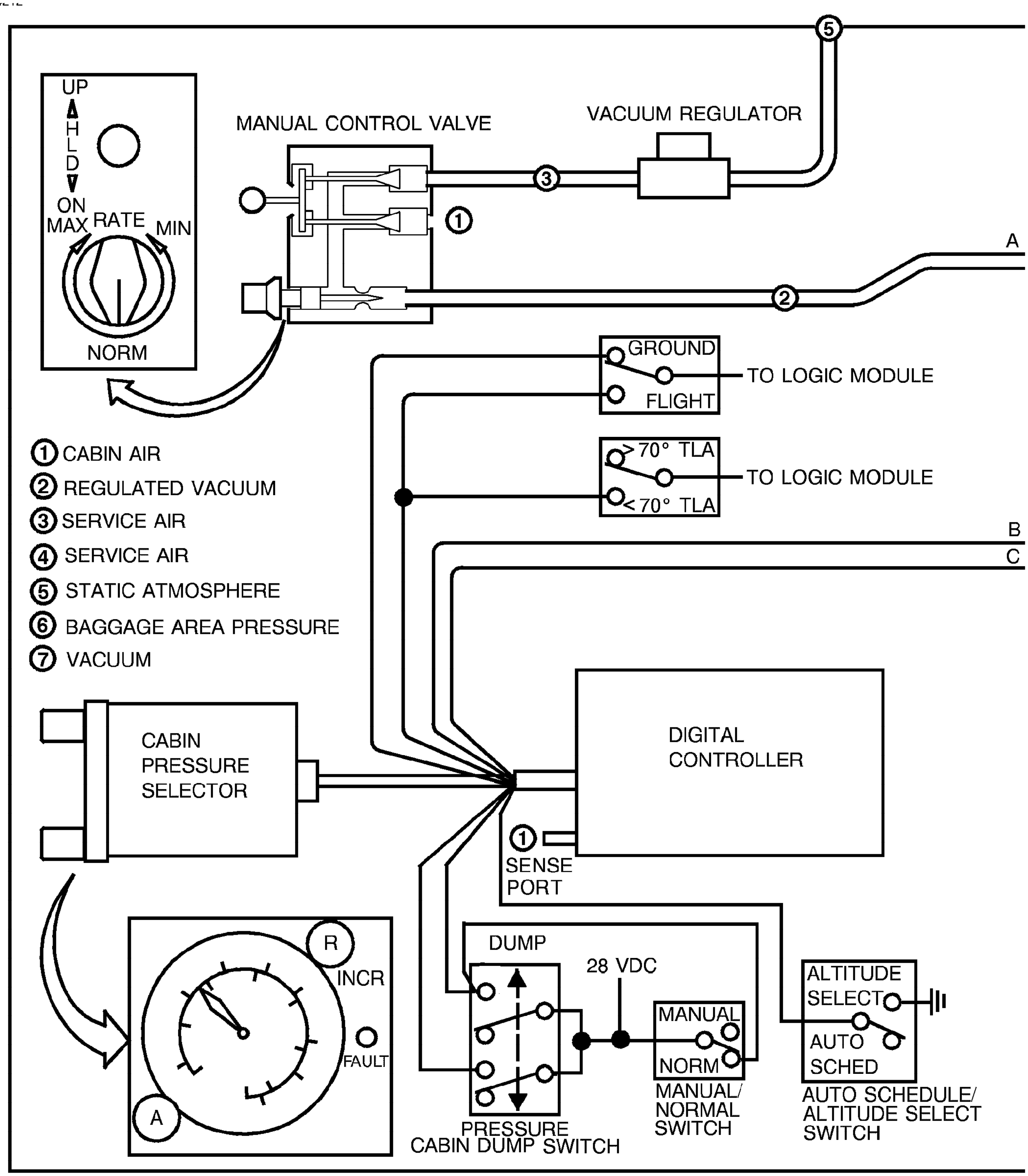


Figure 2-42 (Sheet 1 of 2)

PRESSURIZATION CONTROL SYSTEM

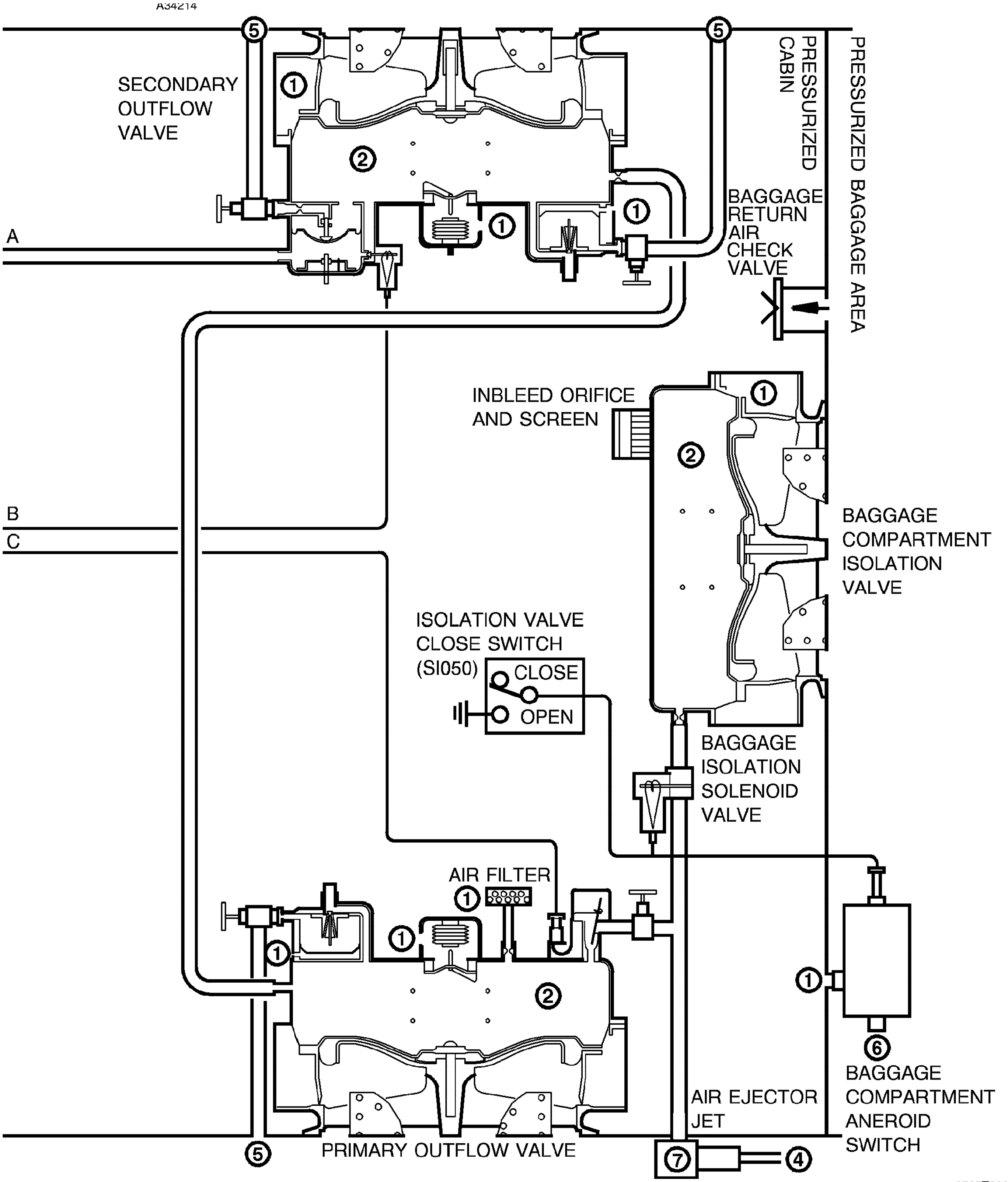
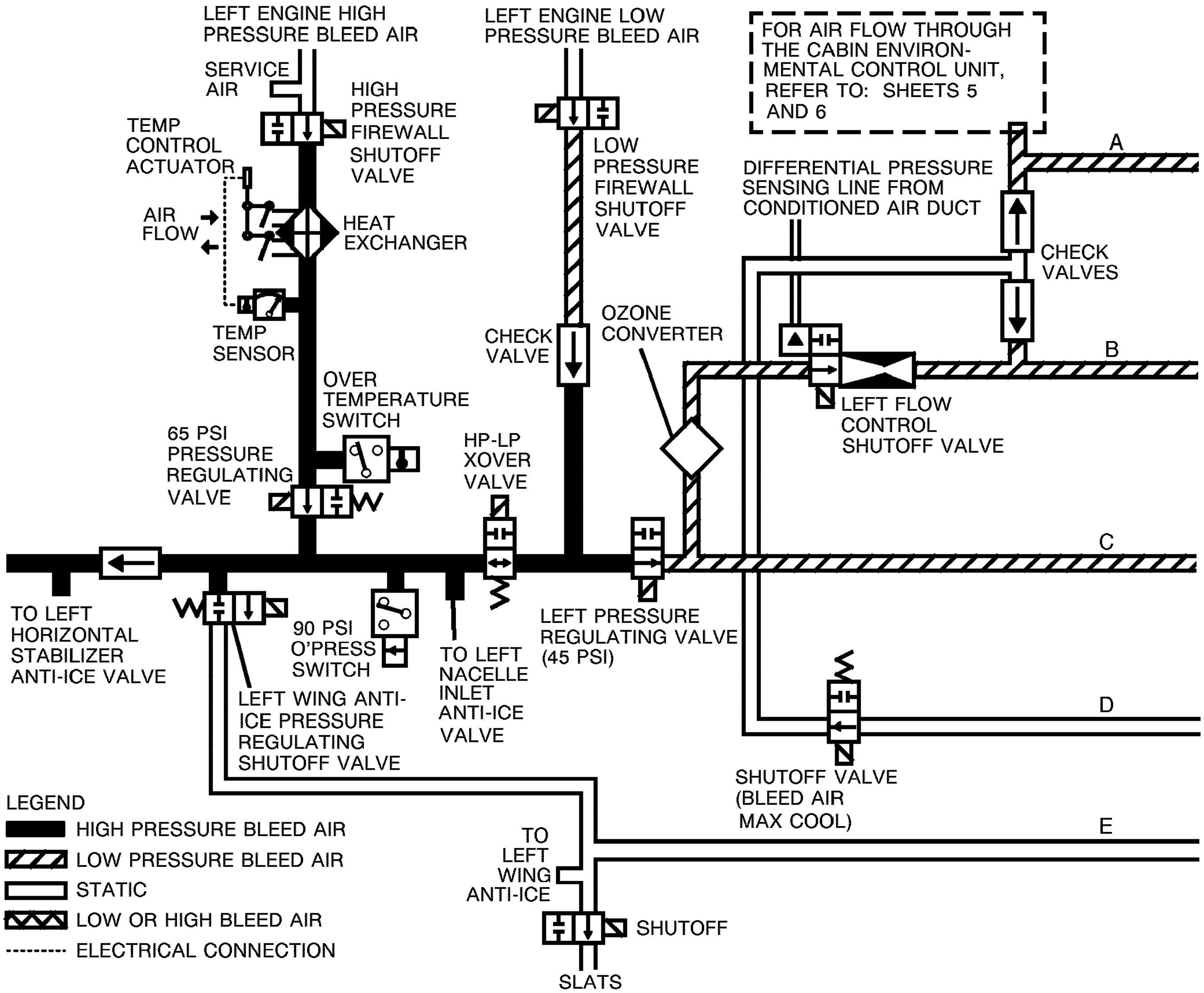


Figure 2-42 (Sheet 2)

BLEED AIR SYSTEM SCHEMATIC

A34216



HIGH PRESSURE BLEED AIR SUPPLYING ENVIRONMENTAL CONTROL UNITS AND ANTI-ICE OFF

6795T7003

Figure 2-43 (Sheet 1 of 8)

BLEED AIR SYSTEM SCHEMATIC

A34218

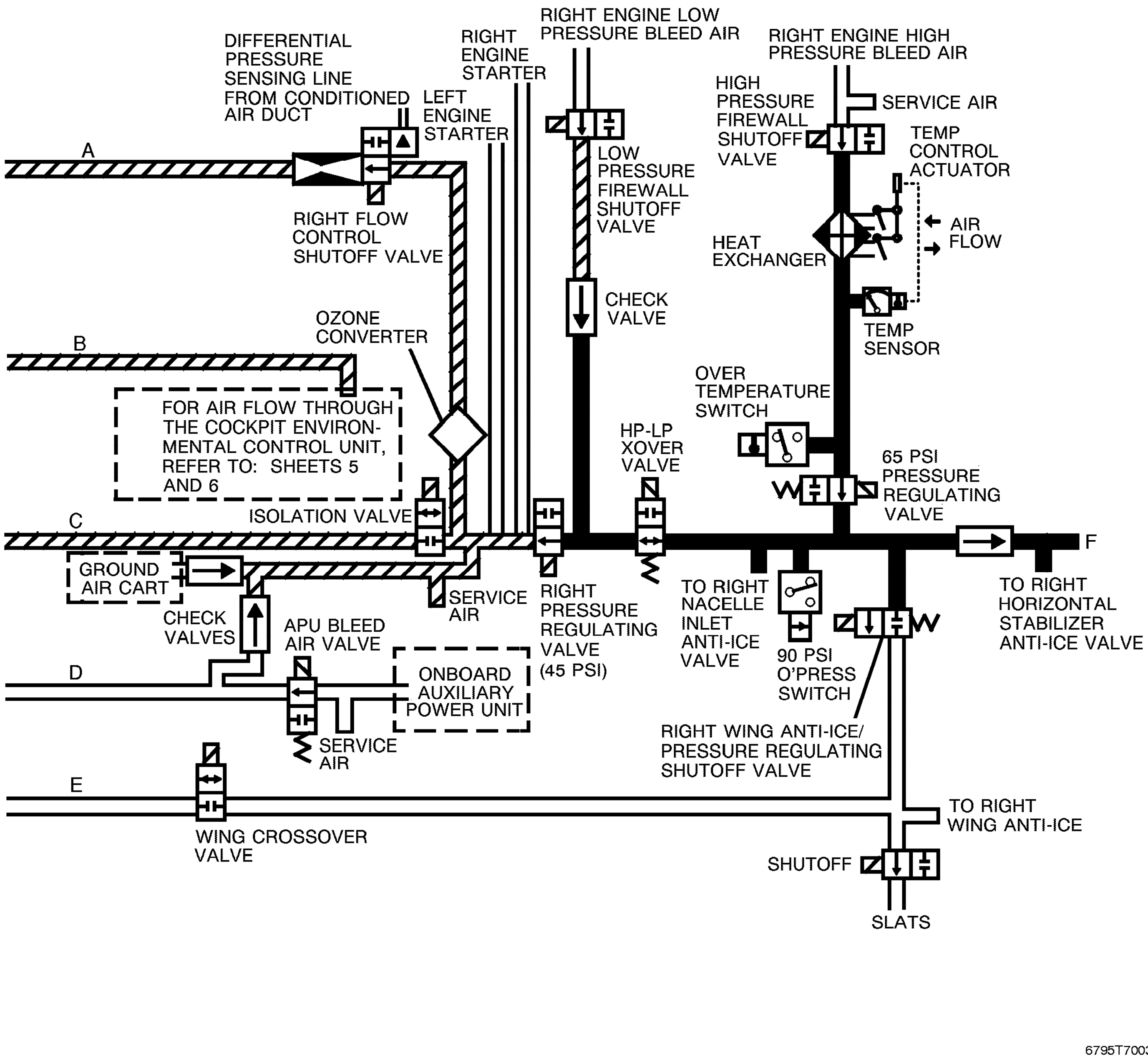


Figure 2-43 (Sheet 2)

BLEED AIR SYSTEM SCHEMATIC

A34210

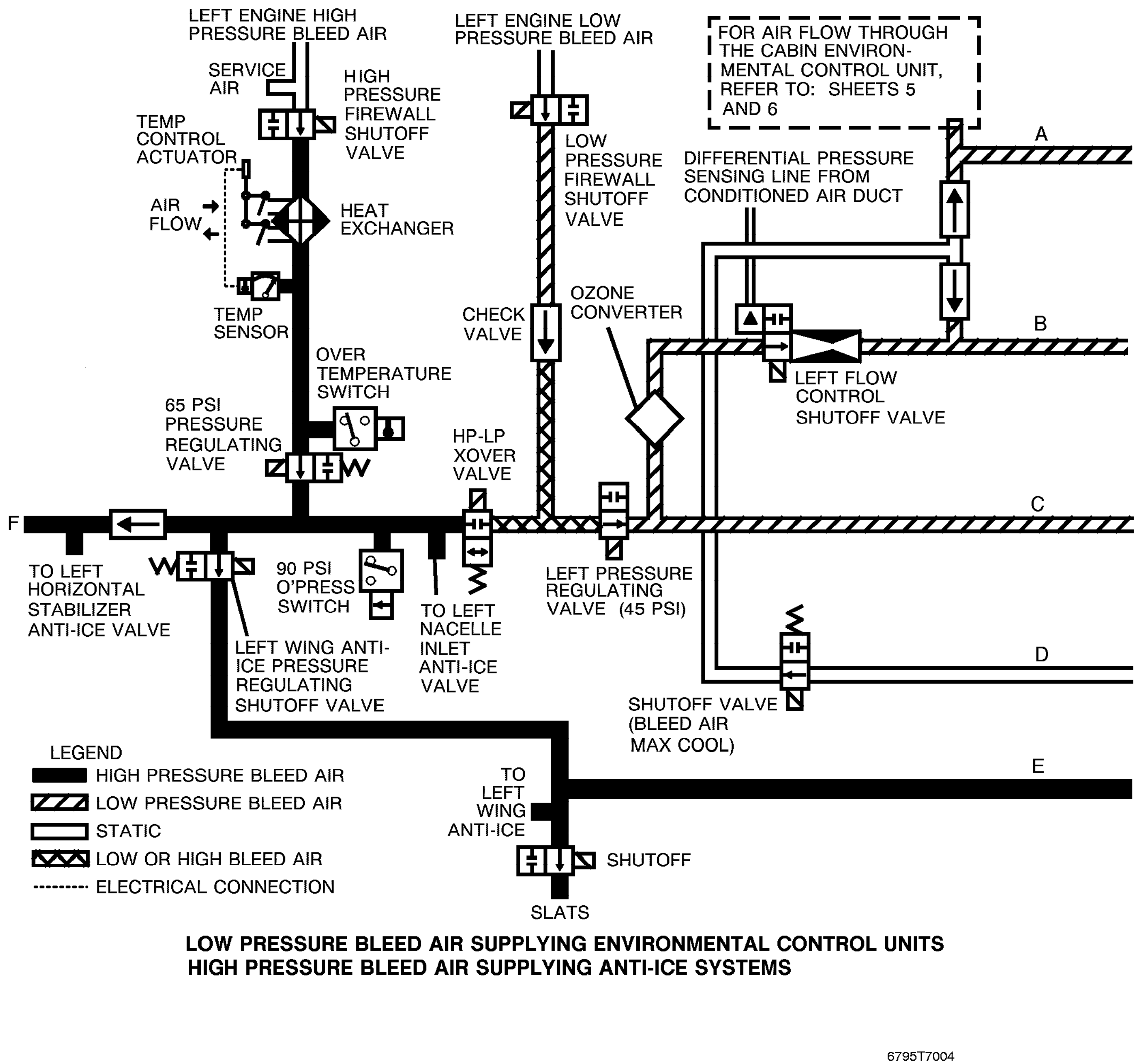


Figure 2-43 (Sheet 3)

BLEED AIR SYSTEM SCHEMATIC

A34213

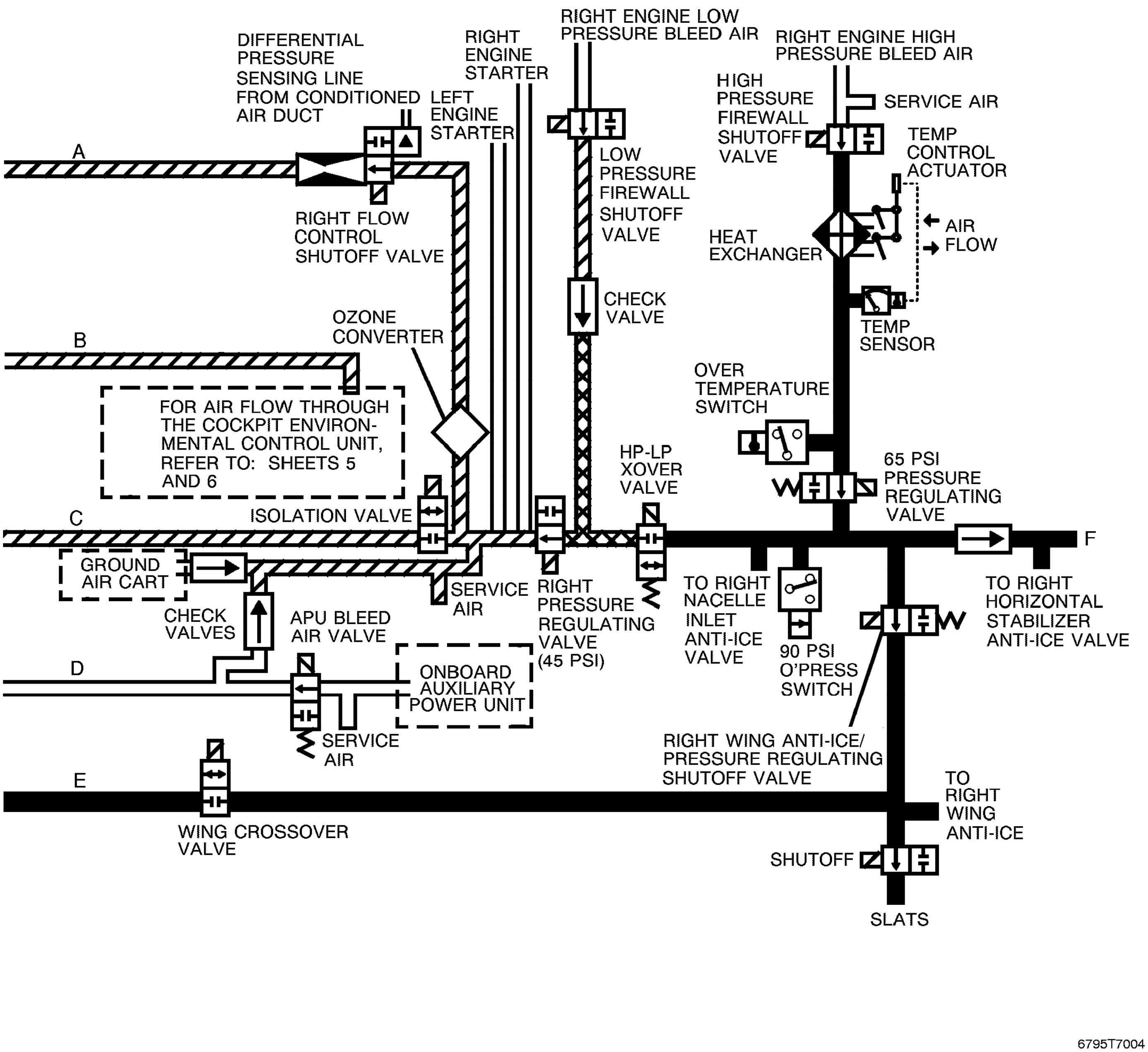
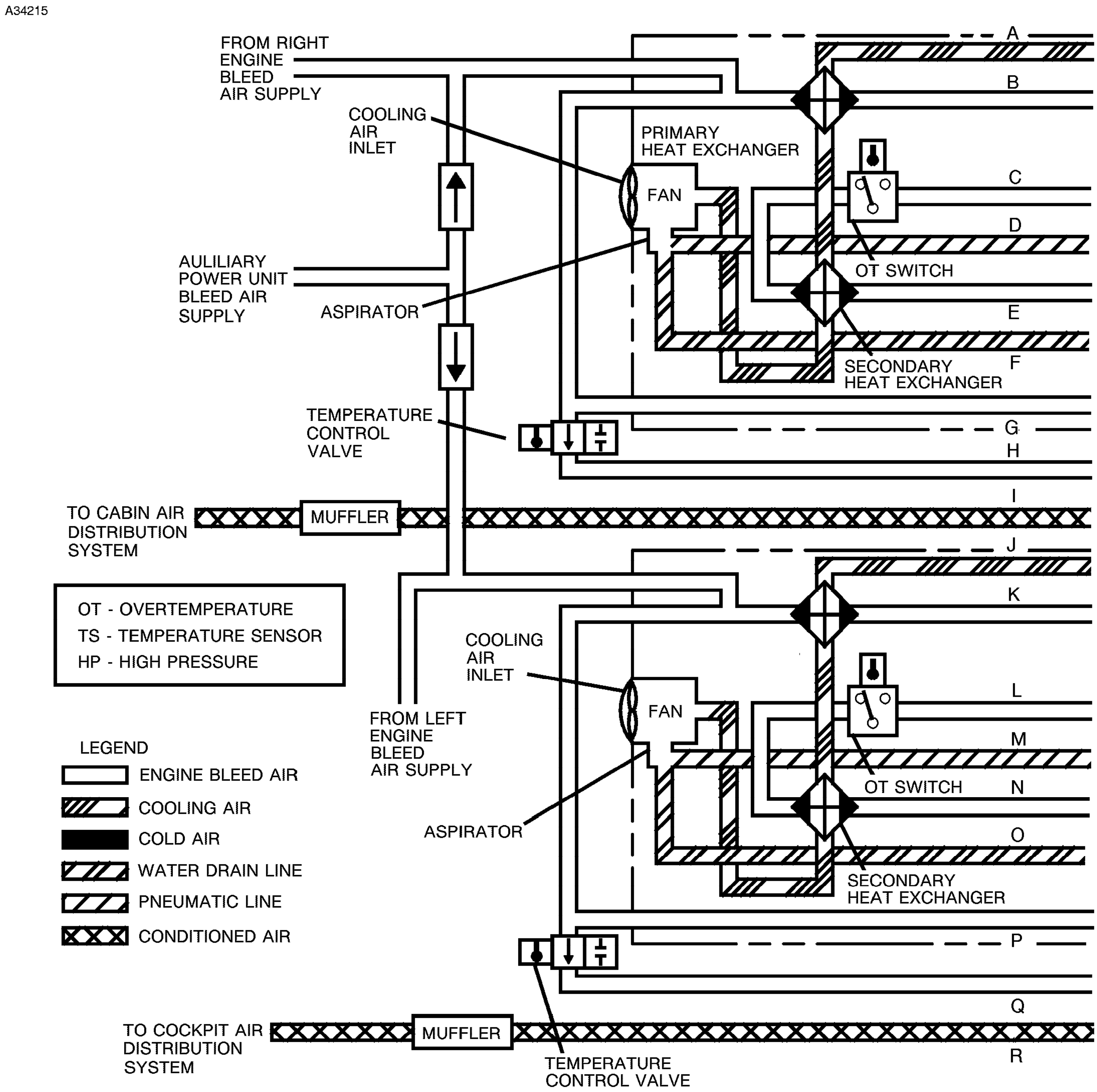


Figure 2-43 (Sheet 4)

BLEED AIR SYSTEM SCHEMATIC



BLEED AIR FLOW THROUGH ENVIRONMENTAL CONTROL UNITS

Figure 2-43 (Sheet 5)

BLEED AIR SYSTEM SCHEMATIC

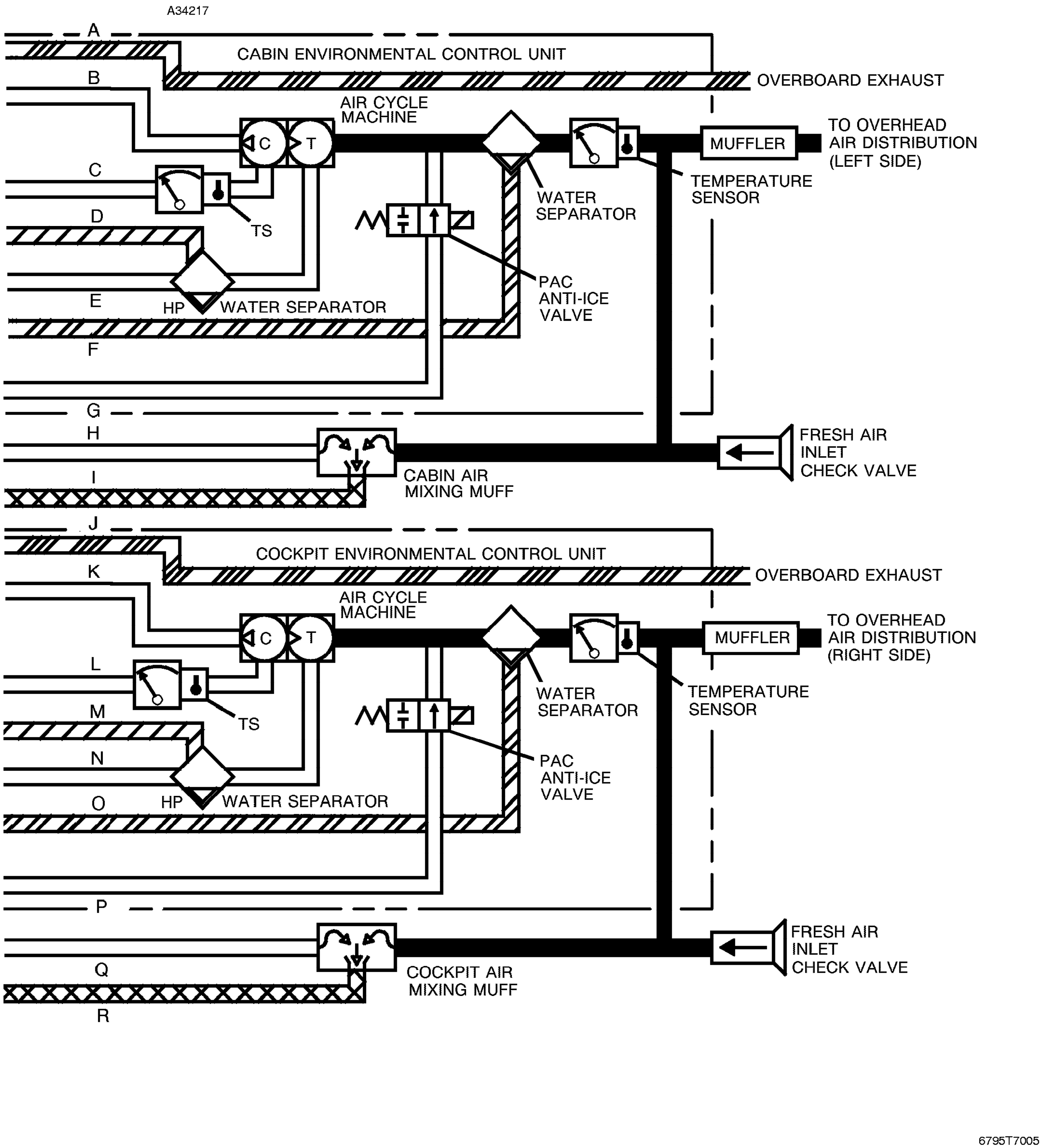
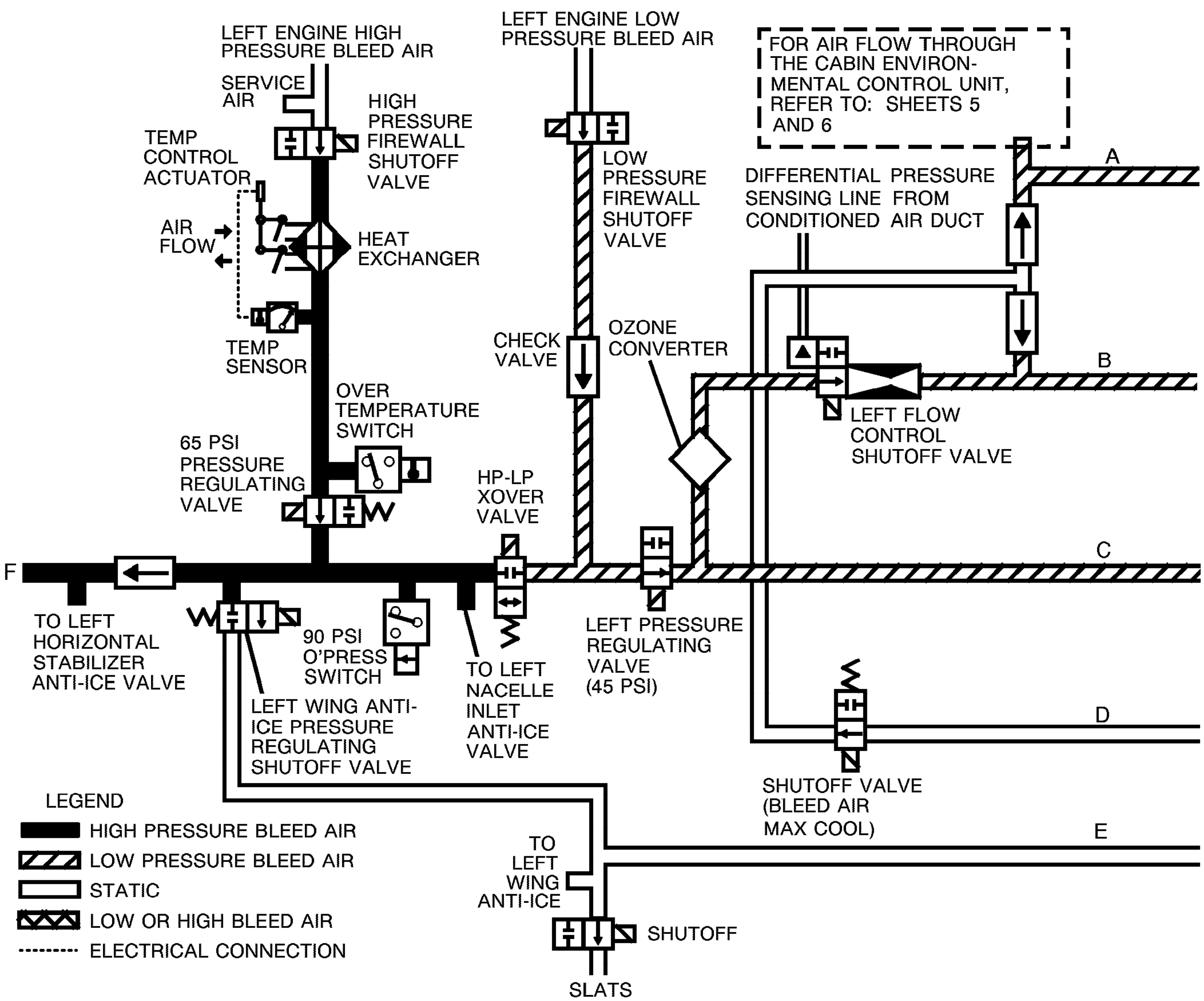


Figure 2-43 (Sheet 6)

BLEED AIR SYSTEM SCHEMATIC

A34219



LOW PRESSURE BLEED AIR SUPPLYING ENVIRONMENTAL CONTROL UNITS AND ANTI-ICE SYSTEMS OFF

6795T7006

Figure 2-43 (Sheet 7)

BLEED AIR SYSTEM SCHEMATIC

A34220

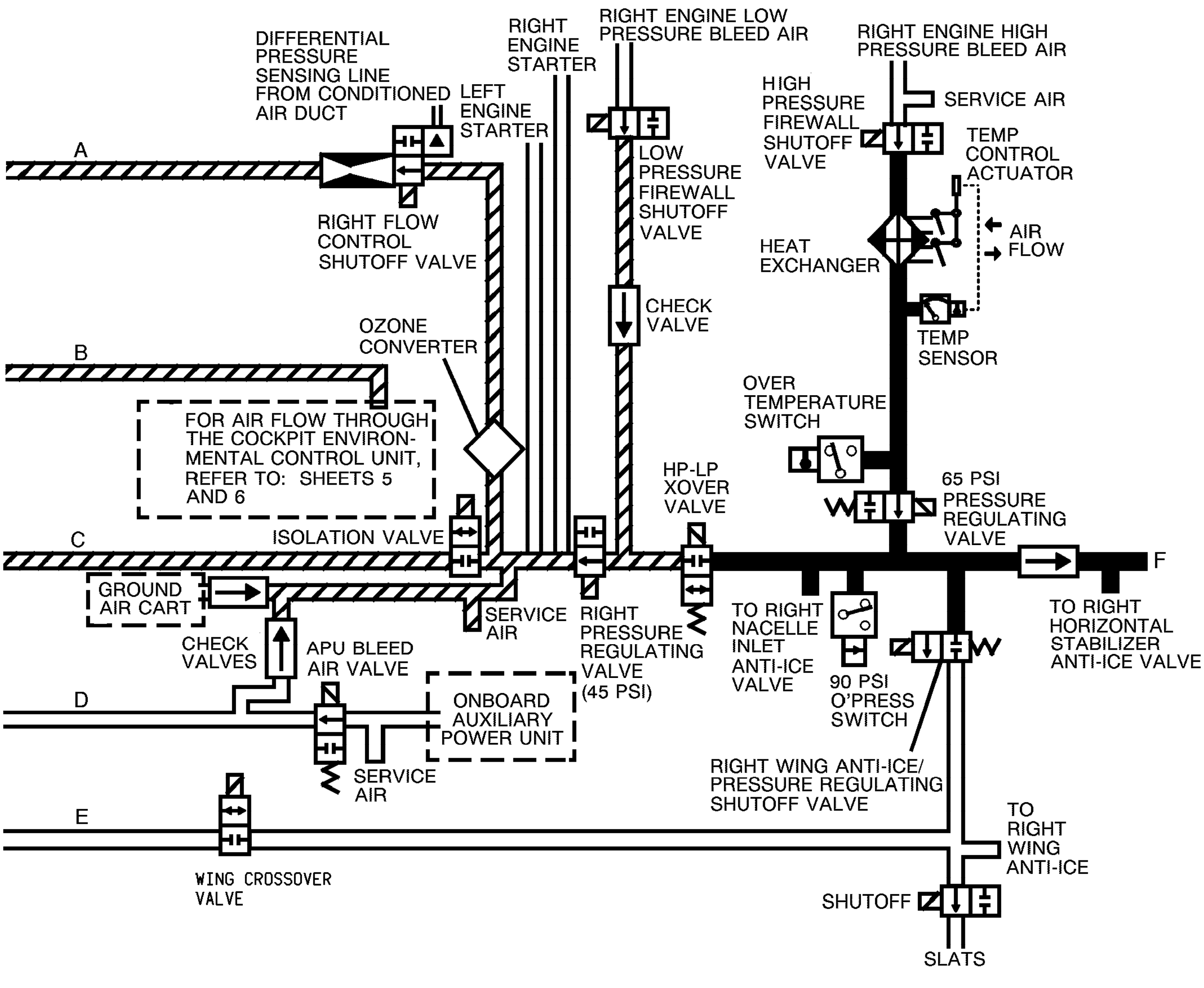


Figure 2-43 (Sheet 8)

ENVIRONMENTAL CONTROL PANEL

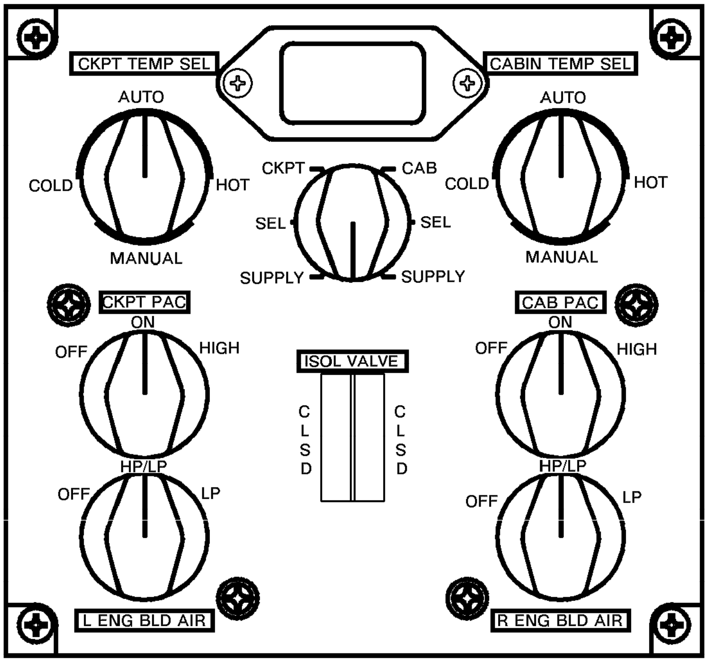


Figure 2-44

CABIN PRESSURE CONTROL

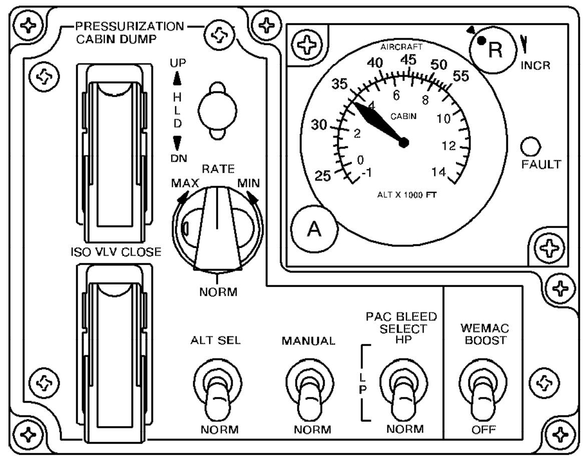


Figure 2-45

In the MANUAL mode, the cabin altitude and cabin altitude rate-of-change are selected by the pilot. Selecting NORM starts a self test as indicated by illumination of the fault light. The fault light should go out within 15 seconds verifying that the controller is functioning properly and that selections of landing altitude and cabin rate-of-change are logical. If at any time during flight, the electrical power is removed from the controller and then reestablished, the FAULT indication lamp will illuminate for less than one second, and then extinguish. If the FAULT indication lamp remains illuminated for longer than fifteen seconds, immediately switch to MANUAL mode of operation.

The pressurization system is capable of holding the cabin altitude to 8000 feet while flying at 51,000 feet (9.3 PSI actual differential). The system also maintains the cabin altitude to a maximum of 8000 feet at flight altitudes greater than 25,000 feet. Some capability in holding maximum pressure differential is lost when the throttles are retarded, anti-ice systems are on and LP is selected. A barometric pressure switch will cause an engine indicating and crew alerting system (EICAS) amber CABIN ALT annunciation to appear if the cabin altitude rises above approximately 8500 feet. A chime tone will be heard. Another EICAS warning (red) will appear if the cabin altitude rises above approximately 10,000 feet. In this case a dual chime will sound. Various other EICAS messages can be triggered by pressure or temperature conditions in the air conditioning system. These, with other system EICAS messages, are covered in detail in Section Three under Engine Instrument and Crew Alerting System (EICAS).

The environmental control unit is made up of two identical Environmental Control Unit Package (ECU or PAC) units; one for the cockpit and one for the cabin. An Environmental Control Unit Package (PAC) contains heat exchangers, air cycle machine and regulators and sensors to cool engine bleed air. PAC output air is mixed with engine bleed air by temperature control valves to produce conditioned air for heating, cooling, and cabin pressurization. Internal PAC temperatures are monitored by the same system which produces EICAS messages to inform the pilot of abnormal conditions. If a PAC overtemperature condition should occur, an EICAS message will be produced and the respective PAC will be shut down until it cools. Each PAC can supply adequate flow to maintain cabin pressure.

The control panel on the far right of the tilt panel contains the switches (L ENG BLD AIR and R ENG BLD AIR) which control the bleed air to the PACs. The left and right bleed air to the PACs is connected by a crossover duct which incorporates an isolation valve (ISOL VLV). If the isolation valve switch (OPEN/CLSD/OPEN) is in the closed (vertical) position, the forward (cabin) PAC is operated using right engine bleed air, and the aft (cockpit) PAC is operated using left engine bleed air. If the isolation valve is in the OPEN position, the two engine sources are connected and either PAC can be run by either engine.

APU bleed air may be used to power the PACs in both ground and air operations. Under normal APU operations, bleed air is routed to the PACs through the engine air start crossover duct. If the BLEED AIR MAX COOL SWITCH on the APU SYSTEM control panel is turned to MAX COOL, additional APU bleed air is plumbed directly into both PACs. The APU BLEED AIR switch must be OFF to start the APU.

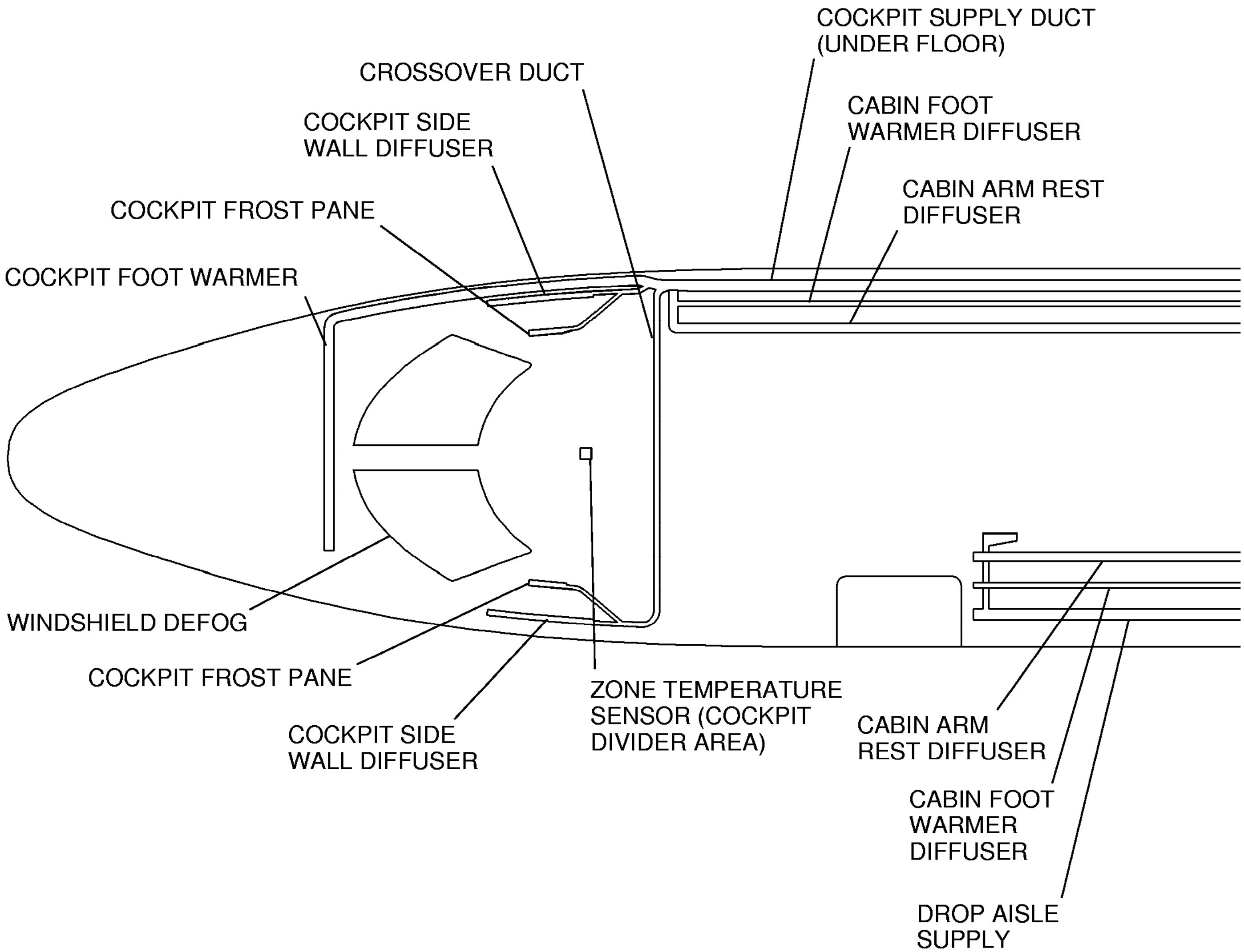
Engine bleed air which is used for pressurization is filtered through an ozone converter (one in each engine bleed system) before it is supplied to the PACs. The ozone converters serve to eliminate contaminants which may be in the engine bleed air. APU bleed air is not filtered through an ozone converter.

A guarded emergency dump switch provides the pilot with a rapid dump capability. CABIN DUMP position causes the outflow valves to open releasing cabin pressure and allowing cabin altitude to equalize with airplane altitude up to 13,000 ±1500 feet.

During ground operations with the landing gear squat switch closed and both throttles at less than 70 percent power setting (N_1), the outflow valves will be fully open to maintain minimum cabin-to-ambient differential pressure control. With at least one throttle advanced to greater than 70 percent fan speed (N_1), the cabin altitude will change to approximately 200 feet below that established by the minimum differential pressure. As the airplane lifts off, the landing gear squat switch opens, establishing the pressurization system in the flight mode. In the flight mode, the cabin altitude climbs, or descends at the programmed rate-of-change, to maintain the cabin altitude appropriate to the airplane altitude. When the squat switch is open, pressurization is no longer subject to throttle position.

AIR CONDITIONING SYSTEM SCHEMATIC

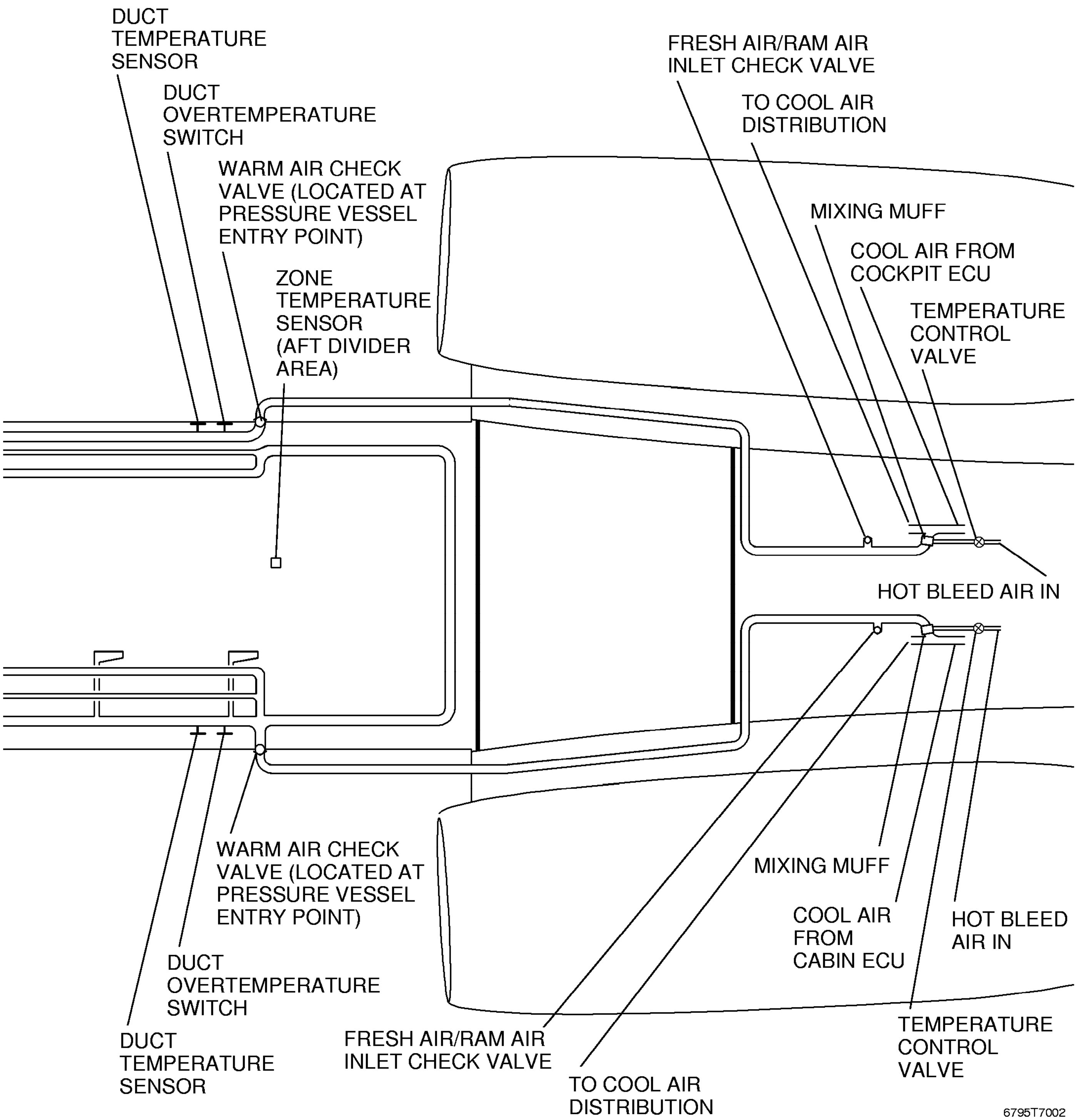
A34224



Warm Air Distribution Flow Diagram
Figure 2-46 (Sheet 1 of 2)

AIR CONDITIONING SYSTEM SCHEMATIC

A34227



Warm Air Distribution Flow Diagram
Figure 2-46 (Sheet 2)

In the event of automatic control system failure, cabin altitude can be raised or lowered by placing the MANUAL/NORM switch to MANUAL and positioning the manual control toggle to UP or DN. The position of the manual RATE knob (RATE MAX/NORM/MIN) will determine the cabin altitude rate-of-change. The toggle is spring loaded to the center HLD (hold) position. The manual system is completely pneumatically operated.

AIR CONDITIONING

The air distribution system directs the flow of heated air, cooled air and/or fresh air to the cabin and cockpit for environmental comfort. Outlets are located overhead, in the armrests and at floor level, including foot warmers in the cockpit, and are positioned to provide windshield defogging. Instrument panel cooling is accomplished by circulating ambient cockpit air behind the instrument panel. Two fans, located below the glare shield, pull cooling air across the electronic equipment behind the instrument panel, and also serve to assist in defogging the windshield. The avionics compartment is cooled by circulating outside air over the avionics equipment. This is achieved by the same fan as is used to remove rain from the windshield.

Citation X airplanes are also equipped with a Wemac boost system for the overhead air distribution system, which mixes cabin air with the colder overhead air to eliminate fogging from the Wemacs and which provides additional cabin and cockpit comfort. A switch labeled WEMAC BOOST/OFF is located on the PRESSURIZATION control panel.

The Environmental Control Unit Package (PAC) switches (cockpit, cabin) on the environmental control panel have OFF, ON and HIGH selections. The system is turned on after the engines are started at which time ON or HIGH may be selected. ON is the normal operating configuration, however, HIGH will provide an increased supply of conditioned air primarily for ground cooling. With the onboard auxiliary power unit operating, either (not both) the cabin or cockpit PAC selector switch may be selected to HIGH. Also on the environmental control panel, are cockpit and cabin temperature controls labeled CKPT TEMP SEL and CAB TEMP SEL. Each control has an AUTO, COLD-HOT and a MANUAL, COLD or HOT selection. A TEMP DISPLAY SEL control is provided to display either cockpit or cabin zone temperatures and their select and supply temperatures by a digital readout. The SEL position allows the selected temperature to be monitored. The SUPPLY position checks the temperature of supply air in the feeder ducts as it is supplied to the cockpit and cabin air distribution systems.

An isolation valve (ISOL VALVE/OPEN/CLSD) switch on the environmental control panel operates the normally closed isolation valve which is located in a connecting duct between the cockpit and cabin bleed air ducts. With the isolation valve OPEN, either engine will operate both environmental control unit PACs in the event of an engine shutdown. If the isolation valve is closed, the right engine operates the forward (cabin) PAC and the left engine operates the aft (cockpit) PAC.

If the cockpit environmental control unit PAC is turned OFF with the cabin PAC in ON or HIGH, a valve in a crossover duct will automatically open, allowing heated air from the cabin duct system to supply the cockpit duct system with heated air.

If electrical power is applied when the cockpit or cabin temperature selector is in the MANUAL position, the temperature controller will not properly complete its automatic power up checks. If the controller has be set to display error codes, it will flash E5 and E6 codes. To clear these codes select AUTO and cycle power to the controller, either by shutting off and restoring all electrical power or by pulling and resetting the COCKPIT TEMP and CABIN TEMP circuit breakers on the left circuit breaker panel.

BAGGAGE COMPARTMENT

The Citation X baggage compartment is pressurized and heated through the same integral system which pressurizes and heats the cabin. The baggage compartment system provides pressurization and temperature control to the baggage compartment and to the baggage compartment mounted avionics. Components of the system which are peculiar to the baggage compartment are the baggage compartment isolation valve, the vacuum solenoid valve, the aneroid assembly, a fan, and the return check valve.

The baggage compartment isolation valve, located on the mid pressure bulkhead, controls the flow of fan driven air from the cabin into the avionics racks located above the baggage compartment. This air exhausts into the baggage compartment and then returns to the cabin through a return air check valve located on the mid pressure bulkhead. The aneroid assembly located in the baggage compartment senses cabin and baggage compartment pressures. The baggage compartment isolation valve will close automatically if the aneroid assembly senses baggage compartment pressures below an atmospheric pressure of approximately 8.5 PSI, or if the cabin to baggage compartment differential pressure is more than approximately 1 PSI. The baggage compartment isolation valve can also be manually closed by the baggage isolation valve switch (ISO VLV CLOSE) on the PRESSURIZATION control panel.