traffic services, and text messaging. It is controlled by the flight management system [17].

Radio altimeter

The radio altimeter, a Honeywell AA-300, works from 2500 feet above ground level to touchdown. (above this altitude, dual standard barometric altimeters provide altitude data). The radio altitude is displayed on the primary flight display [17].

Radios

The Honeywell radio package includes dual RM-855 radio management units with color LCD displays and line select keys for tuning and display selection, dual RNZ-850 navigation units, dual RCZ-833 navigation units, dual VHF omnidirectional range radios, a localizer, a glideslope radio, a marker beacon radio, distance measuring radios, mode-S transponders, and a single automatic direction finder. The VHF communication radios support both 25 kHz and 8 kHz channel spacing [17].

Cockpit Voice Recorder

The cockpit voice recorder has its own underwater locator beacon and is located in the tailcone. It records the data transmitted over the communication radios in addition to cockpit noise from a remote microphone in the instrument panel. The voice recorder stores the last two hours of voice data. A flight data recorder is not standard in the Citation X [17].

Emergency Locator Transmitter

The emergency locator transmitter is located in the tailcone and can be activated manually or automatically. It has its own dedicated battery. When activated it transmits on the 121.5 MHz and 243 MHz emergency frequencies and on the 406 MHz satellite frequency.

The avionics also include weather radar, a traffic alert and collision avoidance system, a ground proximity warning system, high-frequency communication and an audio system with microphones and headsets. In case of avionics failure, there are backup instruments with their own battery [17].

6.3.5. Landing Gear

The Citation X has a tricycle landing gear arrangement, with trailing-link type main gear located on the bottom of each wing and the nose gear located under the nose. A schematic of the system is shown in Figure 27. Each assembly consists of dual wheels attached to an axle at the lower end of a strut. The extension and retraction systems, brakes, and nose-wheel steering are powered by the A hydraulic system and controlled by emergency bus power. The main gear retract into the center of the fuselage and the nose gear retracts into the bottom of the nose cone. The gear are physically prevented from retracting while the aircraft is on the ground, as measured by squat switches incorporated within the gear. The squat switch signals are also used by the pressurization and thrust reverser logic systems.

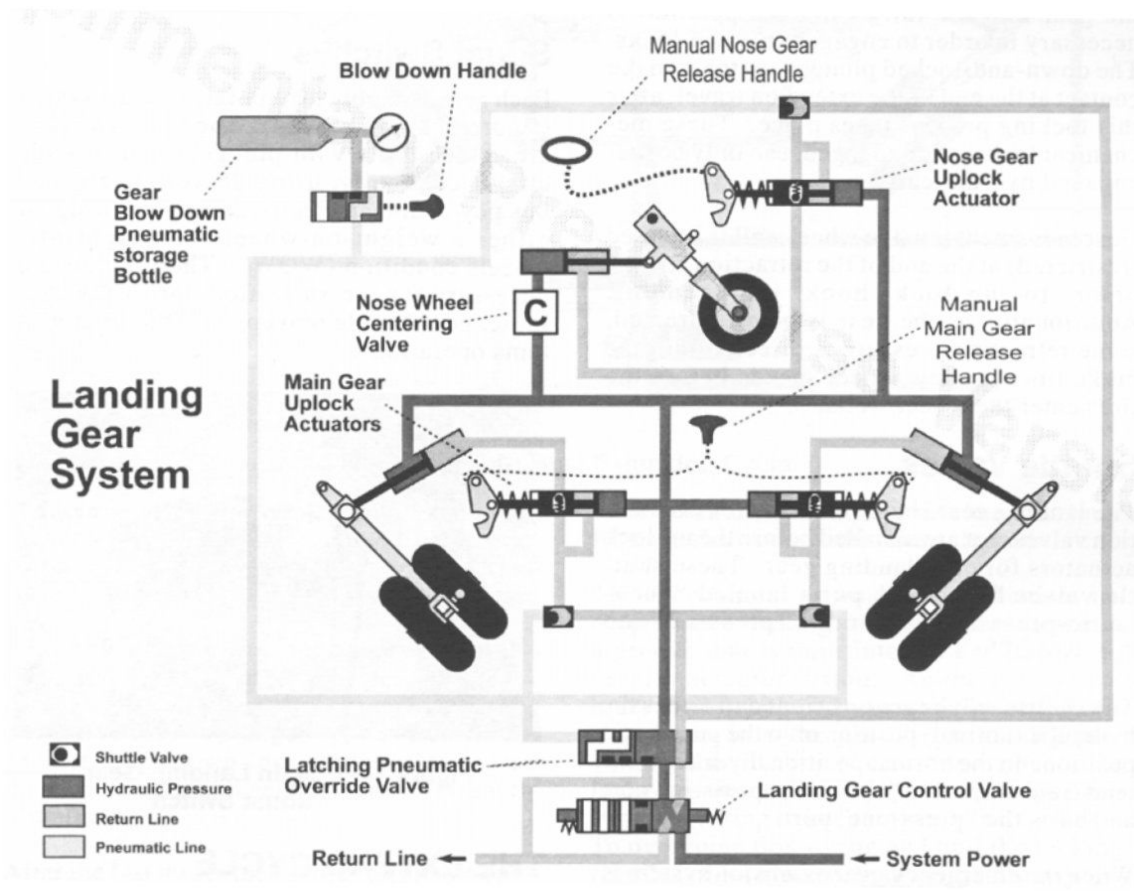

Figure 27: Landing Gear Schematic

If the hydraulic systems fail, the gear can be extended pneumatically, by emptying a high-pressure bottle filled with nitrogen into the landing gear system. The bottle is located in the forward avionics compartment. If both the hydraulic and pneumatic systems fail, the gear-up locks can be manually released to allow gravity to extend the gear.

The requirements for the landing gear are based on the sink rate of the aircraft at landing, comfort for the passengers on the ground, fail-safe operation, and other regulatory requirements.

Brakes

The brake system has four carbon-wheel assemblies. The brakes are normally operated hydraulically on the A hydraulic system. If the hydraulic system fails, the brakes can be operated pneumatically by emptying a high-pressure nitrogen bottle into the brake system. The pneumatic system can provide at least five brake applications before bottle pressure is lost.

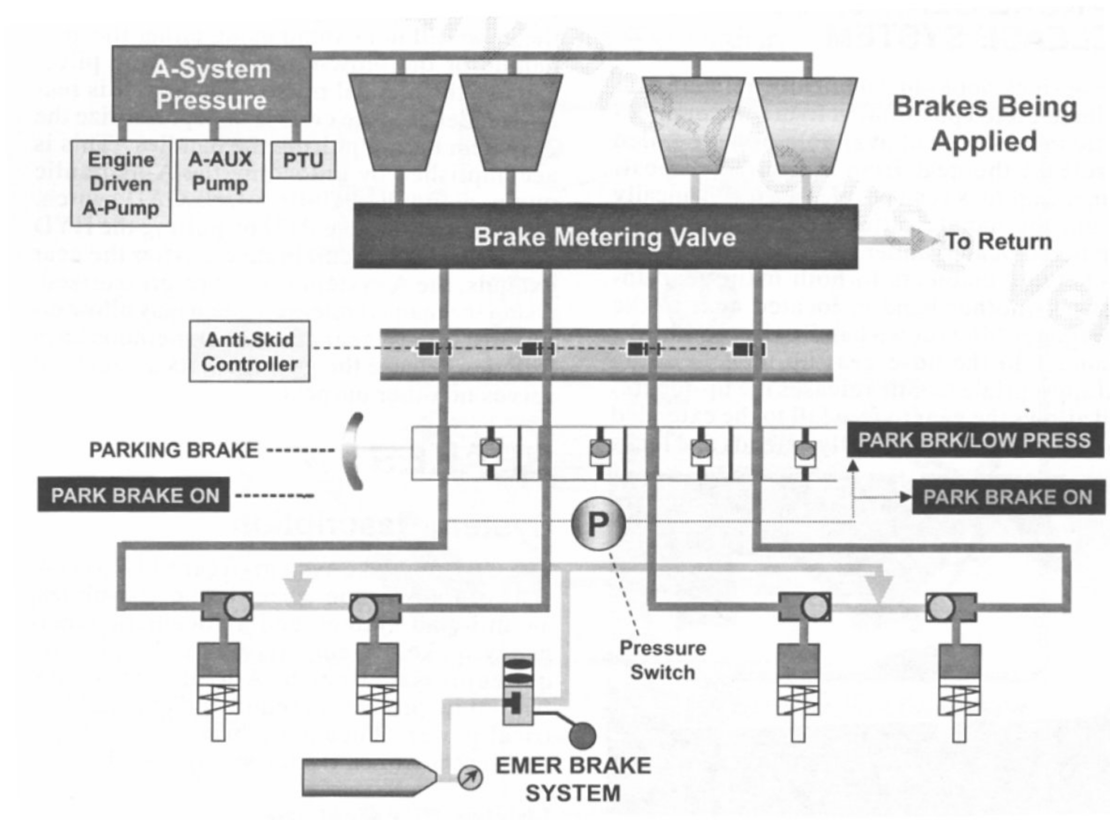

Figure 28: Brake System Schematic

An electric anti-skid system provides independent wheel skid control to each of the four main wheels, prevents brake application before the wheels touch down, and prevents braking on a locked wheel. It uses an analog computer to interpret inputs from wheel-speed transducers, comparing it to an aircraft reference velocity, to remove brake pressure during skid. It waits until either 35-knot wheel spin-up or for five seconds after touchdown before allowing brake application. If the two wheels on the same gear are at significantly different speeds, the skid controller recognizes a locked-wheel condition and prevents brake application on the locked wheel. The system requires A-system hydraulic pressure and DC electrical power.

The design of the brakes is driven by the rate of energy disspation that must be achieved to decelerate the aircraft from the landing speed to zero in the required landing distance. The fail-safe criterion drives redundancy in the brakes.

Nose Wheel Steering

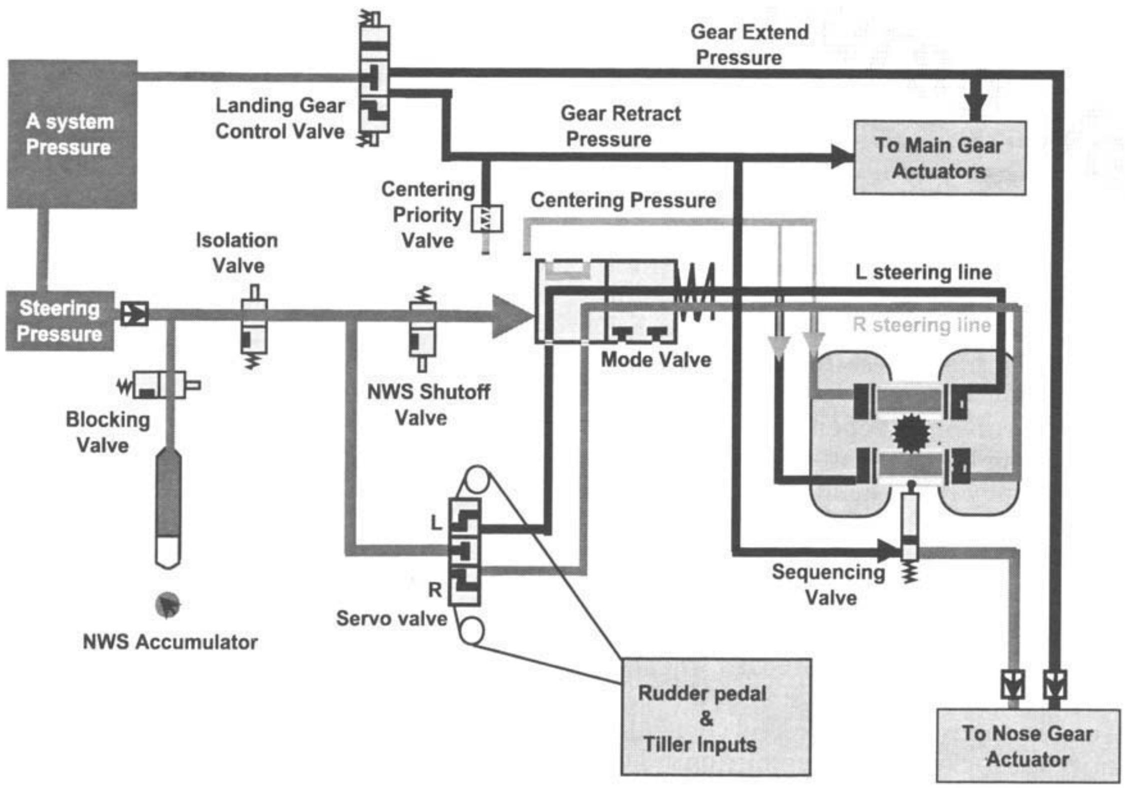

Figure 29: Nose Wheel Steering Schematic

The nose wheel steering system takes inputs from the rudder pedals or a tiller on the pilot's left console and converts these inputs into commands that allow the lower nose strut to rotate. It is active at all times when the aircraft is on the ground as indicated by the landing gear squat switches. It is powered by the A hydraulic system and has a pneumatic system for backup. Normal operation requires DC power from the aircraft electrical system. A schematic of the system is in Figure 29.

6.3.6. Electrical System

There are two different basic designs for the DC electrical system in the Citation X aircraft. The first 100 Citation Xs were built using the first, cross-feed bus electrical system. This system is based on the electrical systems of previous aircraft within the Cessna Citation family [3]. The JAA found the electrical system unacceptable and this necessitated a redesign. Every Citation X with a serial number 101 or higher has the second design, with a split bus. It is apparent from the fact that the JAA demanded major changes in the electrical system that regulatory and safety requirements were the most significant design drivers of this electrical system.

Both systems use the same power sources. Each of the engines drives a 28V, 400A brushless DC generator. A third, identical generator is driven by the APU, which is located in the tailcone for ease of maintenance. The APU also provides bleed air for engine start and for environmental and pressurization needs when the engines are not running. It is certified for in-flight use, but is not required to be operational for takeoff [18]. It can be started in the air and used at any time. The APU requires emergency bus electrical power to start. The generators are controlled by a generator control unit [18].

The engines also drive alternators for 115V 400Hz AC power for the electrically heated windshields and permanent magnet alternators for ignition [18]. The AC systems are simple connections from the alternators to the windshields, and are identical in both electrical designs.

There are two main aircraft batteries. The customer may choose between lead-acid and nickel-cadmium batteries, both of which supply up to 44 amps at 24 volts. They are located on each side of the fuselage aft of the wing fairing. They are used for ground electrical needs, starting the APU, and as an emergency in-flight power source. As an example, in the split-bus system a battery can supply all the electrical load requirements for its bus for approximately 15 minutes or a reduced emergency load for approximately an hour [18].

There is also a smaller 28V battery in the nose compartment used as backup for some standby instruments and two nickel-cadmium batteries behind panels in the cockpit and aft cabin used to power emergency exit lights [18].

The wiring is designed to minimize susceptibility of critical systems to high-intensity radiated fields [17].

The external lighting on the aircraft is composed of two red strobe lights, two anti-collision strobes, two wing inspection lights, navigation lights, two landing/recognition lights, windshield ice detection lights, taxi lights on the nose gear, wing tip downwash lights, and tail logo lights to illuminate the vertical stabilizer.

Cross-Feed Bus Electrical System

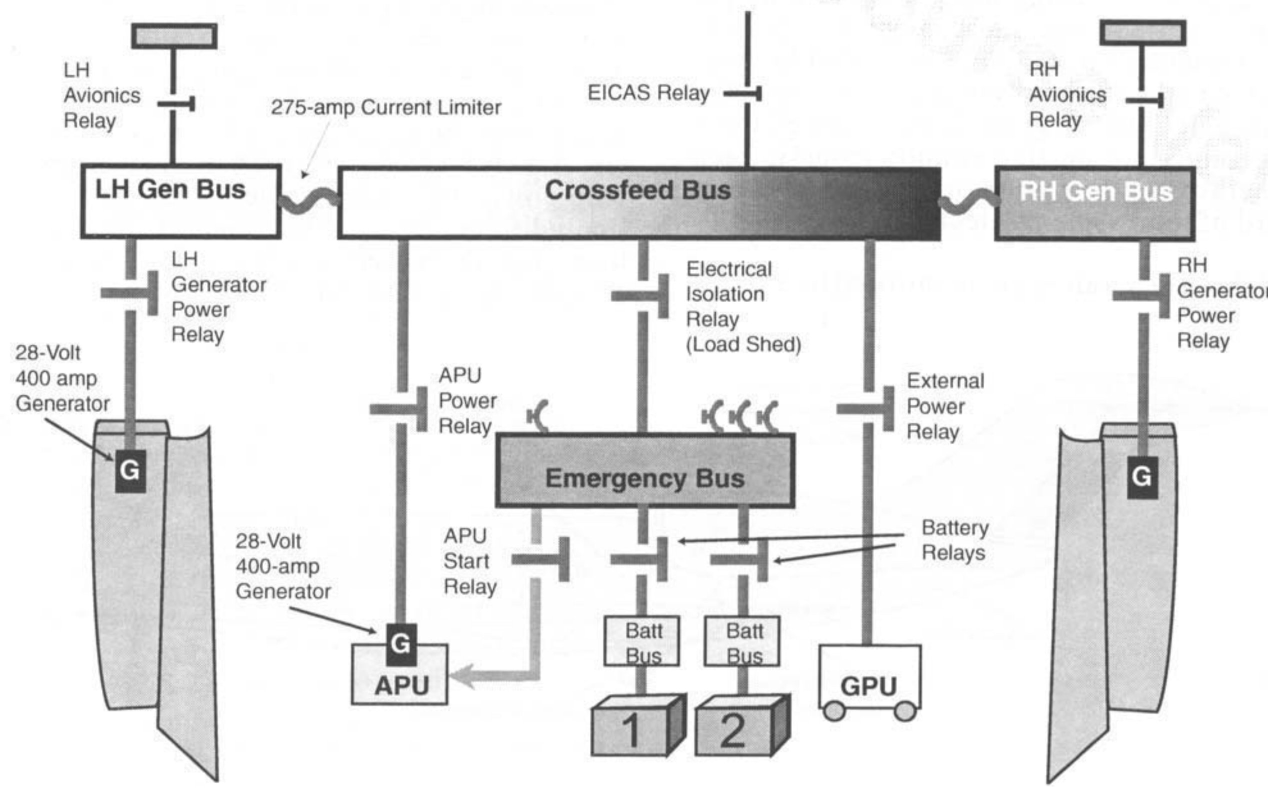

Figure 30: Cross-Feed Bus Electrical System

The cross-feed bus system, shown in Figure 30, has all three generators connected to the same bus. Each generator has its own bus that is electrically connected to the crossfeed bus by a 275-amp current limiter. When all three generators are operating simultaneously, each generator provides approximately one third of the total electrical load. The battery buses are connected to the emergency bus. In normal operation, the emergency bus is connected to the crossfeed bus, so that the generators can charge the batteries and power the systems on the emergency bus. When this connection is broken, the batteries power the emergency bus and the generators power the crossfeed bus. The EICAS bus is connected to the crossfeed bus and the two avionics buses are connected directly to the two engine buses. Emergency avionics systems are powered through the emergency bus.

The major reason for the choice of this design is that it was used on several previous Citations, including the VI and VII. The system is well understood by Cessna and can take advantage of some parts commonality.

Split-Bus Electrical System

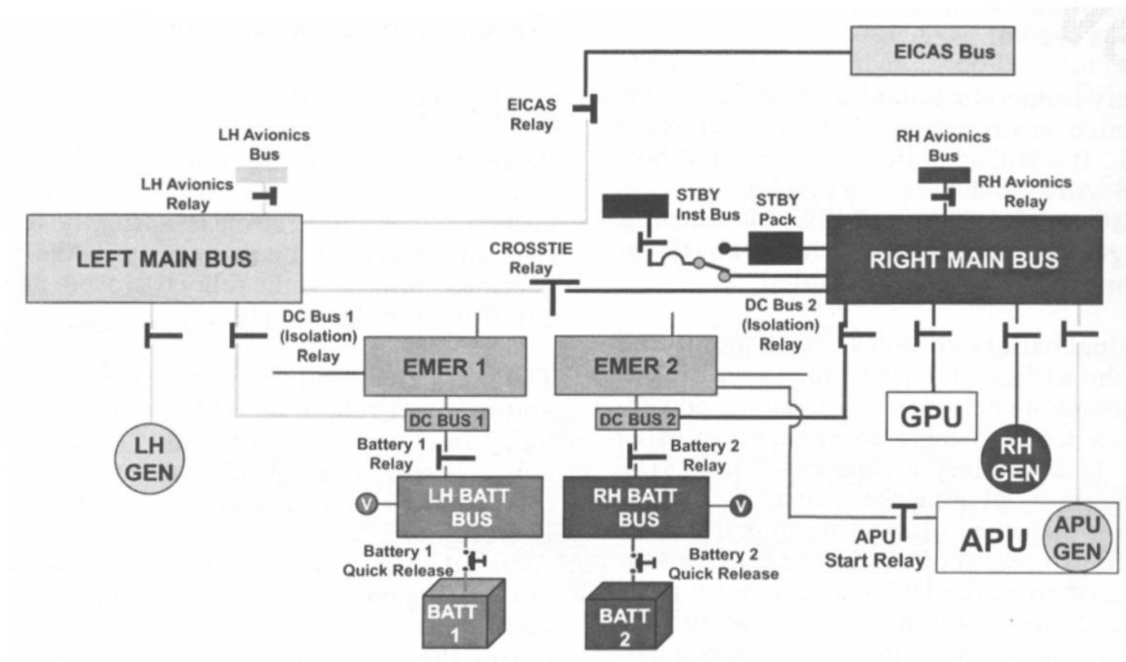

Figure 31: Split-Bus Electrical System

In the split-bus system, shown in Figure 31, the port and starboard generators each operate a separate bus. The two buses are normally separated. The APU generator can connect to the starboard DC-bus system if the starboard engine generator is not connected. The generators do not share electrical load. Each bus has its own backup battery, and there are two separate emergency buses. Figure 32 shows the systems connected to each of the emergency buses.

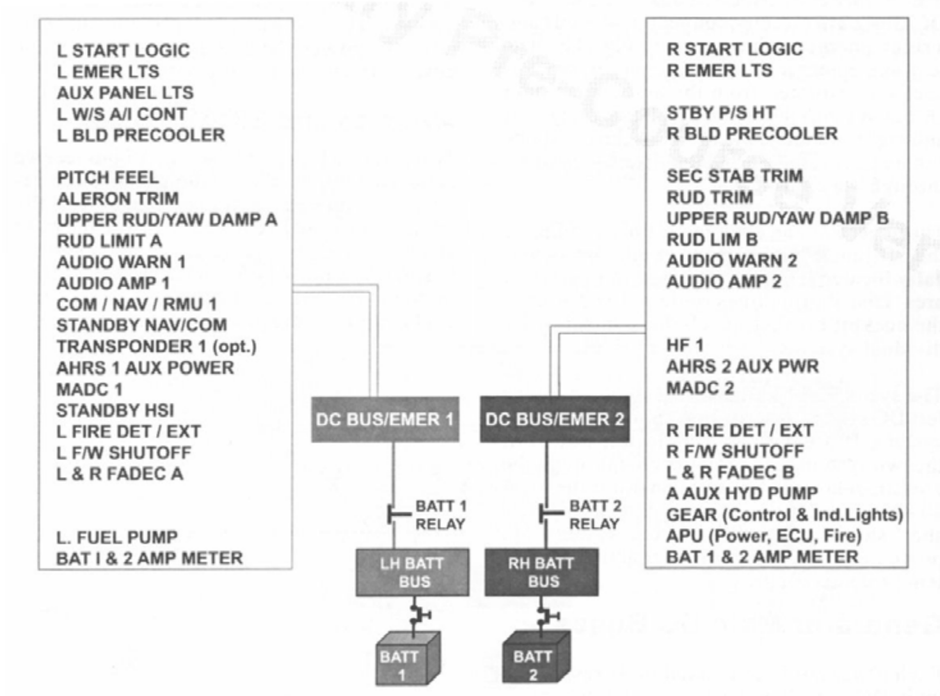

Figure 32: Emergency Bus Items (Split-Bus System)

6.3.7. Pneumatic System

The pneumatic system is shown in Figure 33. It distributes and controls air for pressurization and air conditioning system, explained in section 6.3.8, some elements of the ice protection system, explained in 6.3.9, engine starting, sealing the doors, vacuum ejector pump operation, and ram air temperature (RAT) probe aspiration. The system can get air from three sources: the engines, the APU, or an external air cart. Normally the engines are used for bleed air while in flight and the APU is used on the ground; however, in case of engine failure the APU can be used in flight.

The service air system uses bleed air to inflate the main entry door seal, the entry door acoustic seal, and the baggage compartment door seal. It also heats the baggage compartment to keep the air temperature from dropping below freezing.

During ground operations, service air aspirates both RAT probes. That is, it induces airflow into the probes when the aircraft is not moving. This is necessary to ensure an accurate temperature source for the air data computers, which input into the FADECs for calibration of thrust values.

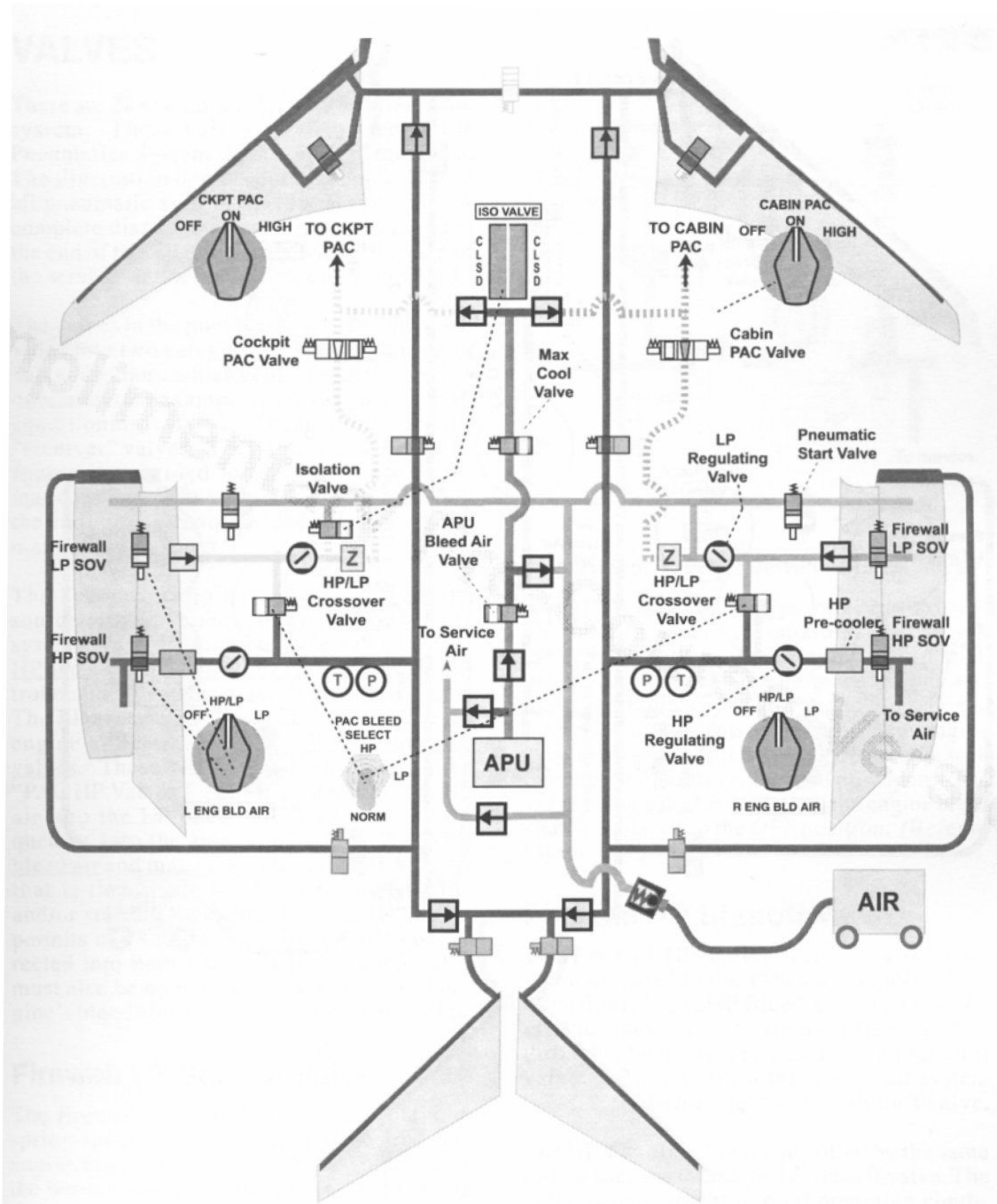

Figure 33: Pneumatic System Schematic

6.3.8. Environmental system

The environmental system, or pressurization air conditioning (PAC) system, directs bleed air from the engine or the auxiliary power unit into the cockpit and cabin for pressurization, ventilation, and air conditioning.

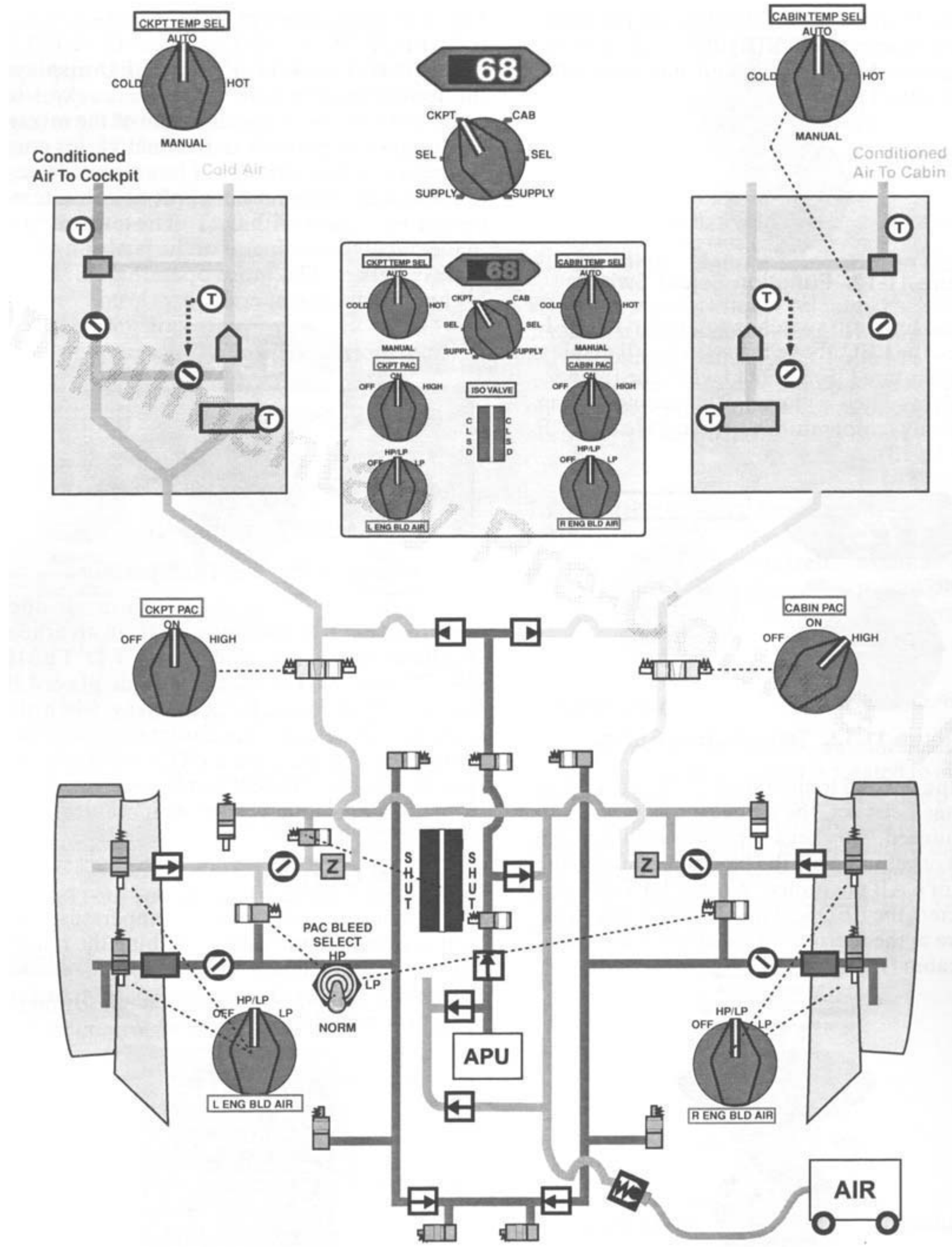

Figure 34: Air-Conditioning System Schematic

The safety and passenger comfort requirements drive the design of the system.

The pressurization is controlled by the amount of hot and cold air entering the cabin and the amount of air that is vented from the cockpit through the two outflow valves. The system can maintain a nominal maximum pressure differential of 9.3 psi [17].

This allows a cabin altitude of 8000 ft at an altitude of 51000 ft. The system is certified to a pressure differential of 9.7 psi [18]. A schematic of air conditioning system is shown in Figure 34.

There are two PAC units located in the tailcone, one for the cockpit, and one for the cabin. They take hot bleed air from the engine. The cockpit PAC uses bleed air from the port engine and the cabin PAC uses bleed air from the starboard engine. The hot air is divided into two parts: one that goes through a cooling process in an air-cycle machine, and the other that bypasses the cooling process. The air-cycle machine is a heat exchanger that uses ram air passing through the tailcone to cool the bleed air. The temperature control switches in the cockpit and the cabin control the amount of air in the hot-air bypass line. The hot and cool air mix within the PAC and are then distributed to vents in the cockpit. This system also includes overheat sensors and a water separator.

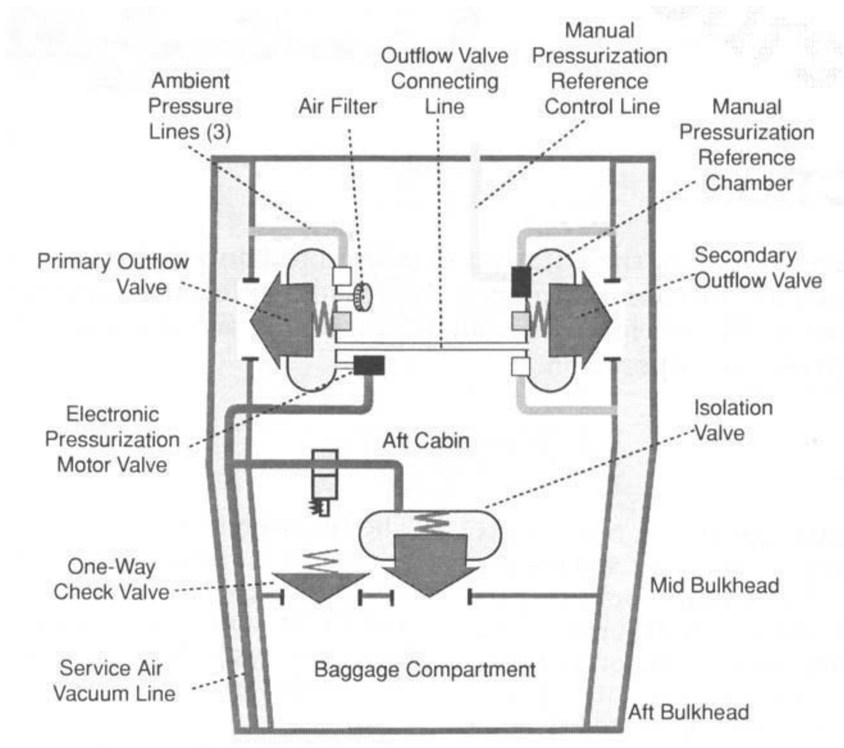

Figure 35: Pressurization System Components

Figure 35 shows some components of the pressurization system. Pressurization is controlled by controlling the amount of air that leaves the aircraft through the two outflow valves. This can be controlled manually from the cockpit, semi-automatically through an altitude select function, or fully automatically, controlled by the PAC. The fully automatic pressurization schedule is shown in Figure 36. The outflow valves are on each side of the cabin near the aft pressure bulkhead. Air passing through these valves enters the main landing gear compartment. A third valve is located at the back of the cabin, between the cabin and the baggage compartment. Air from the cabin enters the baggage compartment through the valve, circulates through it, and re-enters the cabin through a one-way check valve.

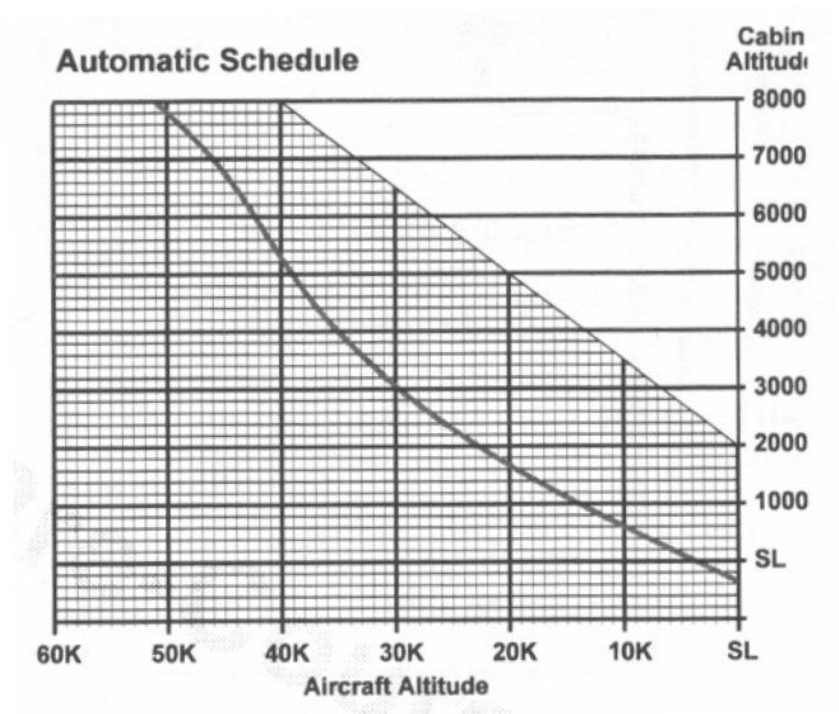

Figure 36: Automatic Pressurization Schedule

The baggage compartment is a class D compartment, meaning that it does not have a fire-suppression system. Instead, the valves between the cockpit and the baggage compartment can be closed to isolate the baggage compartment in case of fire or toxic fumes.

6.3.9. Ice protection System

The ice protection system is composed of five main anti-icing systems, each operated separately. The first system uses hot bleed air from the engine to heat the slats and the fixed leading edge of the wing. The second system is the engine anti-ice system. The engine anti-icing switch controls both the bleed air to the engine cowl intake area and to the fixed sections of the inboard wing, and the DC power that heats the small cuff at the juncture of the wing and fuselage. The third system heats the leading edge of the horizontal stabilizer using engine bleed air. The fourth system uses 3-phase AC power from engine-driven alternators to heat the front windshield and side windows. If one alternator fails, partial windshield heat is still available for portions of both sides of the windshield. The windshield heating system requires DC bus power for control. The fifth system is the probe heating system. It uses aircraft DC power to heat the pitot tubes, static ports, ram-air temperature probes, and angle of attack probes on each side of the aircraft and the standby pitot tube on the starboard side of the aircraft.

The Citation X is also equipped with an anti-rain system for the windshield for use on the ground. A fan in the nose cone blows air from the avionics compartment over the windshield. The system is ineffective for rain removal during flight. The airflow over the windshield removes rain from the windshield in flight and the surface of the windshield is sealed with a rain-repellant coating [18].

The requirement for high-altitude flight and the customer preference for all-weather operation in combination with regulations necessitated the ice protection system.

6.3.10. Oxygen System

The oxygen system provides an emergency automatic-dropout oxygen mask for each passenger from a 49 cubic-foot (standard) or 76 cubic-foot (optional) oxygen bottle, charged to 1850 psi, located in the forward avionics bay, with a high pressure gauge and a bottle-mounted reducer that reduces the pressure to 70 psi before distribution to the crew and passengers. The crew is provided with pressure demand masks fitted with microphones [17]. The oxygen is provided when the pressurization system fails or smoke is detected in the cabin or cockpit [18]. There is also a portable 11 cubic foot bottle with multiple connections stored in the forward portion of the cabin. The oxygen system is needed to satisfy regulatory and safety requirements. It is shown in Figure 37.

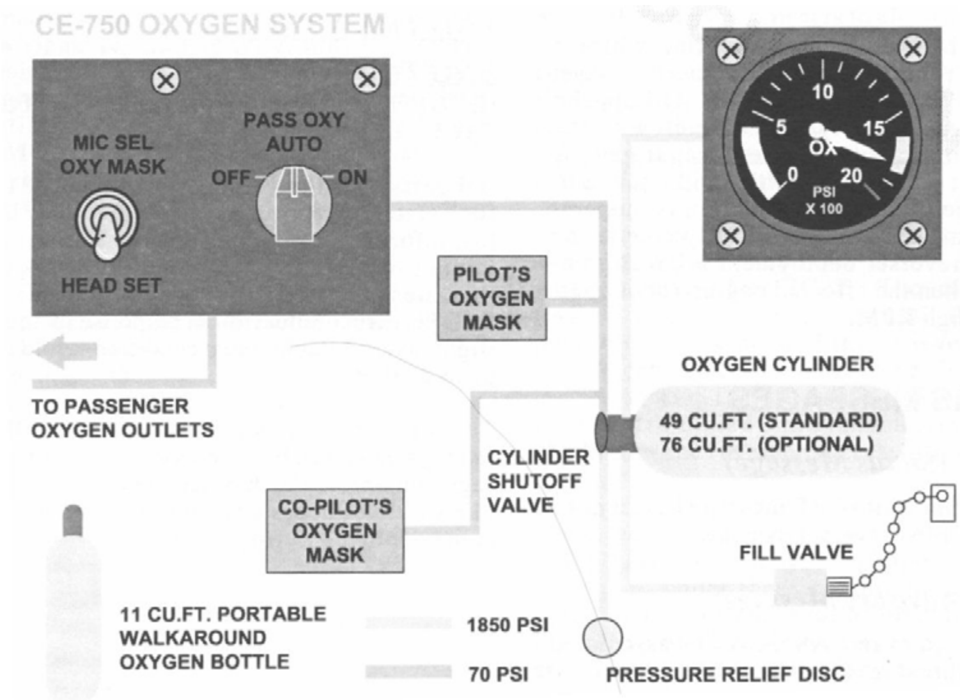

Figure 37: Oxygen System

6.3.11. Angle of Attack System

During flight-testing, Cessna found that at high altitudes (above 35000 ft) high angles of attack could disturb the airflow entering the engines enough to cause an engine flameout. To prevent this and ensure the aircraft became reliable, a minimum speed warning system was incorporated. When the aircraft reaches the critical angle of attack above 35000 ft, the angle of attack system reports to the crew that they have reached the minimum speed and the crew is required to respond by immediately increasing the airspeed.

There are two identical angle of attack systems for redundancy. Each has an angle of attack probe mounted outside the aircraft. The probes rotate to achieve uniform pressure on their upper and lower surfaces and their angular positions are converted to an angle of attack by an angle of attack computer, which also takes inputs from the flaps, slats, and speed brakes in order to compensate for each configuration. The probes are electrically heated for anti-icing.

The angle of attack system activates stick shakers on the control columns when a speed of $1.1*V_{STALL}$ is reached. Also at that speed, the slats are automatically extended. Angle of attack indicators are optional components of the angle of attack system [18].

6.3.12. Controls

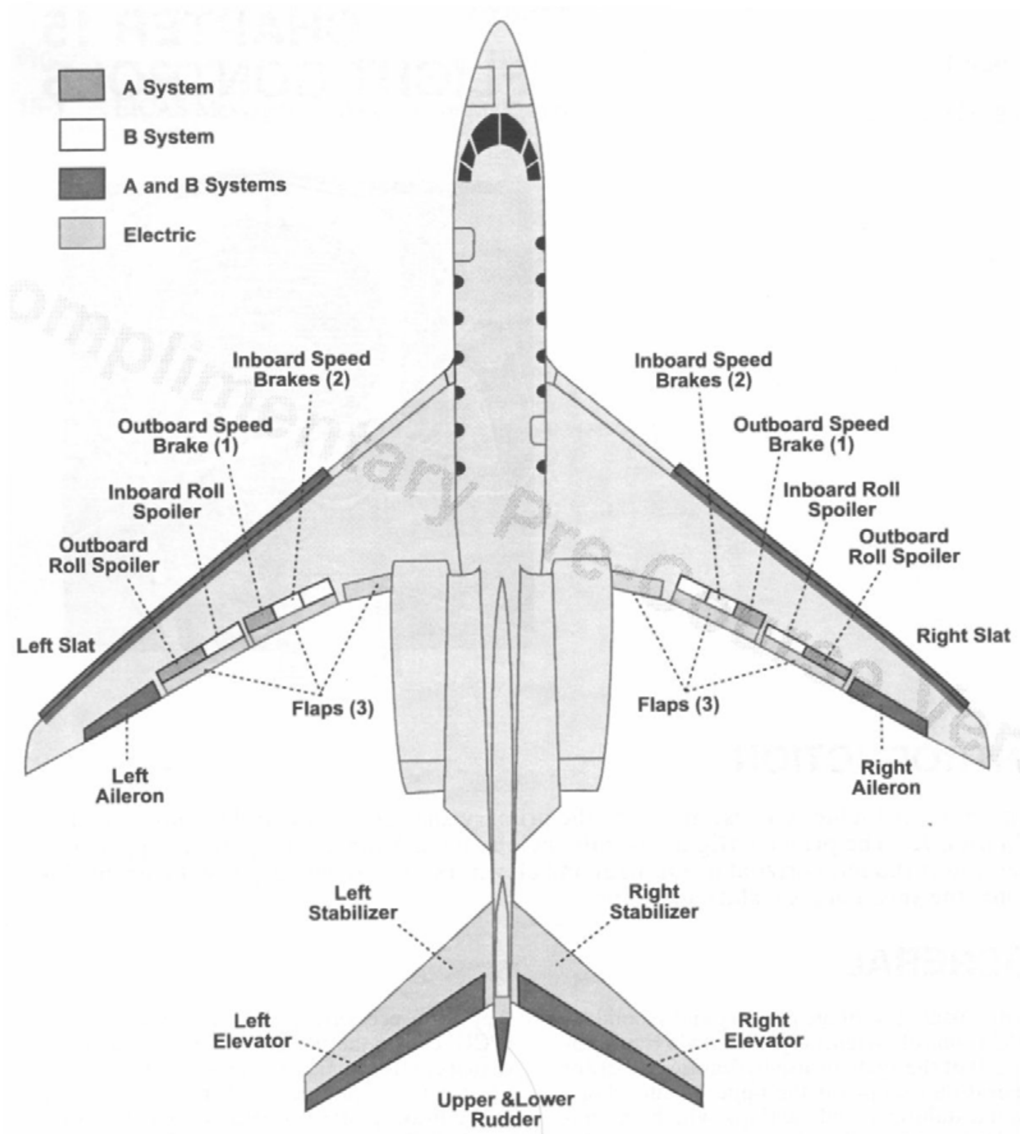

Figure 38: Control Surfaces

The controls on the Citation X are powered either electrically or hydraulically. All control surfaces are shown in Figure 38 with the actuation system indicated. The hydraulic controls are dual hydraulically-powered [17]. Each hydraulic actuator, manufactured by Moog, has an individual power control unit (PCU): a small, self-