

National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



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AIRWORTHINESS

Group Chair's Factual Report

September 3, 2024

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A. ACCIDENT

Location: Montebello, VA
Date: June 4, 2023
Time: 1523 eastern daylight time
1923 coordinated universal time (UTC)
Airplane: Cessna 560 Citation V, N611VG, Serial Number: 560-0091

B. AIRWORTHINESS GROUP

Group Chair	John Flynn National Transportation Safety Board Washington, District of Columbia
Group Member	David A. Gerlach Federal Aviation Administration Washington, District of Columbia
Group Member	Ricardo Asensio Textron Aviation Wichita, KS
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C. SUMMARY

On June 4, 2023, about 1539 eastern daylight time, a Cessna 560 Citation V, N611VG, was substantially damaged when it crashed in a rural mountain area 1.5 miles north of the Montebello VOR, after being NORDO and overflow destination airport at FL340. Multiple military aircraft were scrambled to intercept the aircraft. The pilot was observed unresponsive prior to crashing. The pilot, and three passengers were fatally injured. The airplane was operated under the provisions of Title 14 Code of Federal Regulations Part 91.

D. AIRCRAFT SYSTEMS INFORMATION

1.0 FLIGHT DECK LAYOUT

Figure 1 below shows the general layout of the cockpit with the master warning lights, annunciator panel, and pressurization - environmental control panel highlighted.

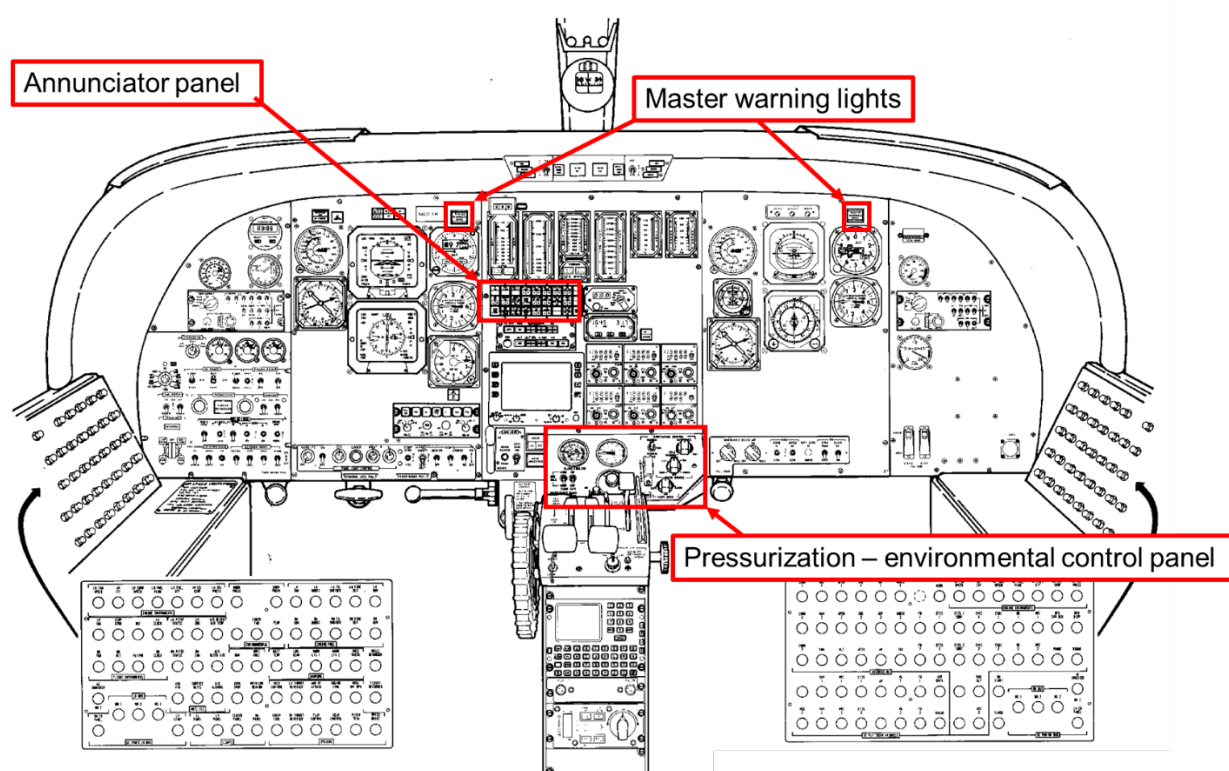


Figure 1. Cockpit layout. (Courtesy of Textron Aviation)

2.0 ENVIRONMENTAL CONTROL SYSTEMS

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 cabin rate-of-climb and temperature. Ram air for cabin ventilation is available when the pressurization system is not in use.

2.1 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 V, 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. Figure 2 shows the cabin pressure control system schematic.

2.1.1 Outflow Valves

There are always two forces at work on the outflow valves. The first is a spring which is always attempting to close the respective valve, restricting the outflow of air, and causing the cabin altitude to descend. Offsetting this spring is the control air (vacuum) regulated by the cabin pressure controller and amplified by the pneumatic relay. This tends to pull the outflow valve off the seat and allow air to escape, ascending the cabin altitude. If control vacuum should exceed limits due to a malfunction, cabin altitude limit valves are provided to prevent cabin altitude from exceeding $13,000 \pm 1,500$ feet. If the control vacuum exceeds the barometric reference in the cabin altitude limit valves, they will open and release cabin air into the control air line, reducing the vacuum. This will cause the outflow valves to move toward the closed position and reestablish cabin pressure. An emergency dump valve located on the vacuum line can be utilized to route vacuum directly to the outflow valves and dump cabin pressure to a cabin altitude of $13,000 \pm 1,500$ feet. Unless the Pressure Source Selector is OFF, the pressure will not dump completely.

Bleed air from the engines is used to create a vacuum for cabin pressurization control.

When either or both engines are operating, bleed air is directed through a pressure regulator and an air ejector. Air passing through the ejector creates a vacuum at an air inlet port, which is the pickoff point for the vacuum system. A filter in the system removes foreign particles from the air. A regulator is included which regulates the vacuum pressure between 3.75 and 4.75 inches of mercury.

In the event of a vacuum system failure, the emergency dump valve will be inoperative and cabin pressure will go to maximum differential since control air (vacuum) is not available to the pressurization outflow valves.

2.1.2 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 (ACM) for cooling before entering the cabin.

Each engine has two ports from which compressor discharge air (bleed air) is bled off the engines. Two control valves, one mounted in each pressurization bleed air line, controls 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 operations.

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, ground (GND), left hand (LH), normal (NORM), right hand (RH) and emergency (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 ACM to ventilate the cabin. With this position selected, the BLEED 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 ON annunciator light will illuminate. The ACM 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.

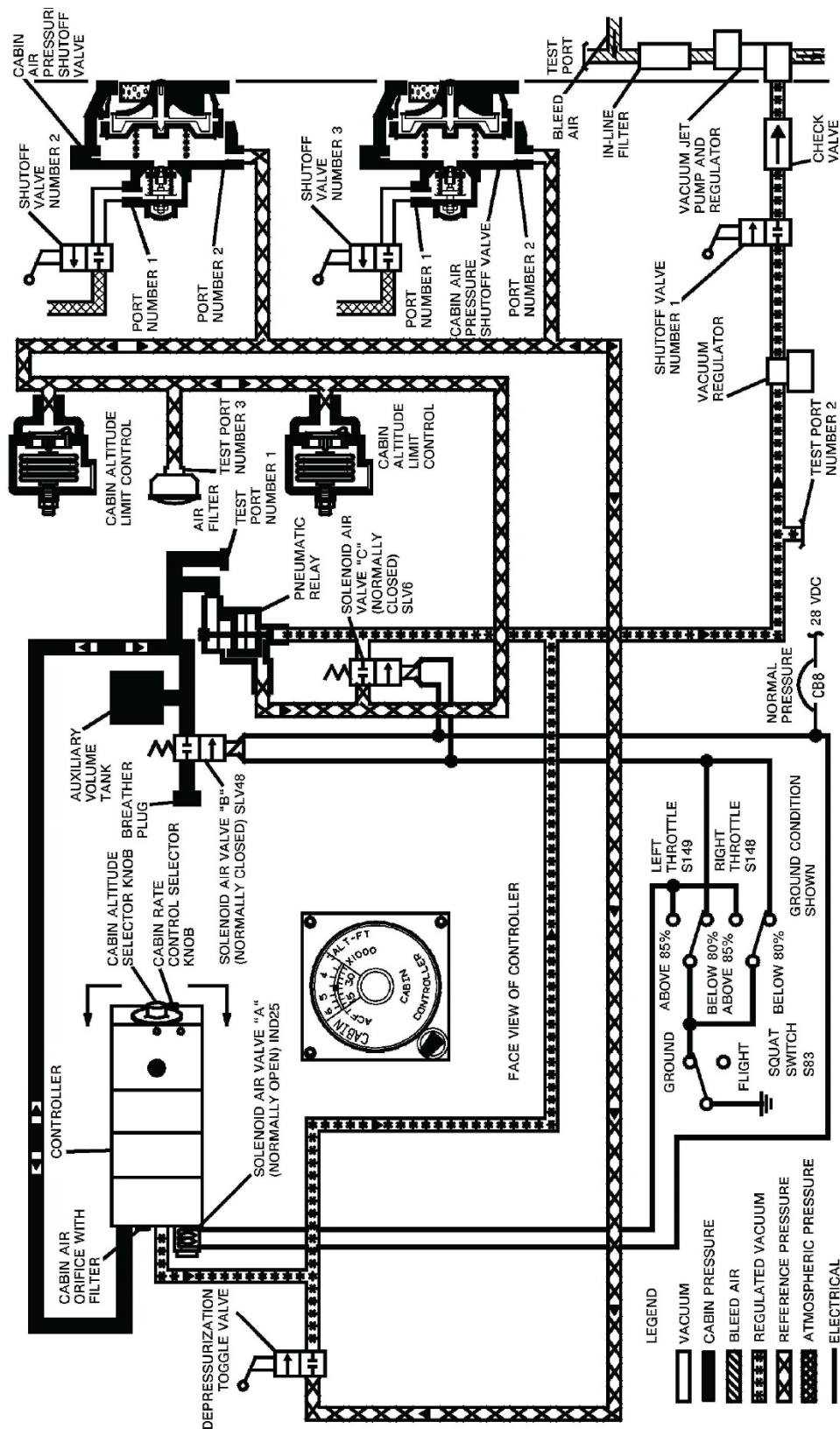


Figure 2. Cabin pressure control system schematic. (Courtesy of Textron Aviation)

2.1.3 Pressurization Controller

It is the function of the controller to meter control air (vacuum) to the outflow valves so that desired cabin altitude and rate of climb are achieved. Figure 3 shows the environmental control panel.

The controller consists of two chambers separated by a moveable diaphragm. One chamber senses cabin pressure while the other chamber references ambient pressure trapped prior to liftoff. Pressure differences between the two chambers, resulting from an increase in cabin altitude, cause the diaphragm to move and route control air to the pneumatic relay. The pneumatic relay amplifies this signal and in turn, controls the two outflow valves. Cabin pressure is then increased or decreased until equilibrium between the two chambers is established.

Desired cabin altitude is selected by rotating the cabin altitude selector knob. This applies a spring bias to the moveable diaphragm and changes the pressure differential at which equilibrium between the two chambers is achieved.

The rate at which the cabin climbs or descends is controlled by the cabin rate knob. This valve bleeds air between the two sealed chambers and, in conjunction with an isobaric bellows, determines the rate at which the spring pressure is applied to the moveable diaphragm when a new cabin altitude is selected.

The cabin altimeter and cabin rate of change indicators are located on the center pedestal adjacent to the pressurization controller. The cabin altimeter presents existing cabin altitude on the outer scale, and pressure differential on the inner scale. The pressure differential needle will indicate a malfunction of the outflow valve whenever a pressure differential more than 8.9 pounds per square inch (PSI) is shown on the gage. The cabin rate of change indicator shows the rate at which the cabin is ascending or descending.

The outflow valves are calibrated to regulate cabin differential pressure at 8.7 ± 0.1 PSI. During ground operation, vacuum is routed directly to both outflow valves, driving them to the fully open position (or partially open during takeoff run). This assures that the airplane is depressurized during all ground operations. During the takeoff roll, advancement of the throttles closes three solenoid valves, moving the outflow valves into the controlling range. The pilot selects the altitude he is going to and on takeoff the cabin altitude increases to that equivalent altitude (outside pressure for the altitude selected plus 8.7 psi). The rate knob selects the rate at which the cabin will get to that equivalent altitude.

A guarded emergency dump switch provides a rapid dump capability for the pilot. The emergency dump (EMER DUMP) position causes the pressurization outflow valves to open, releasing cabin pressure and allowing cabin altitude to equalize with

airplane altitude up to approximately 13,000 $\pm$ 1,500 feet. The pressure source selector must be OFF to obtain complete depressurization of the cabin at altitudes above 13,000 $\pm$ 1,500 feet. The cabin altitude limit controls prevent a system failure or inadvertent pilot action from depressurizing the cabin above this altitude.

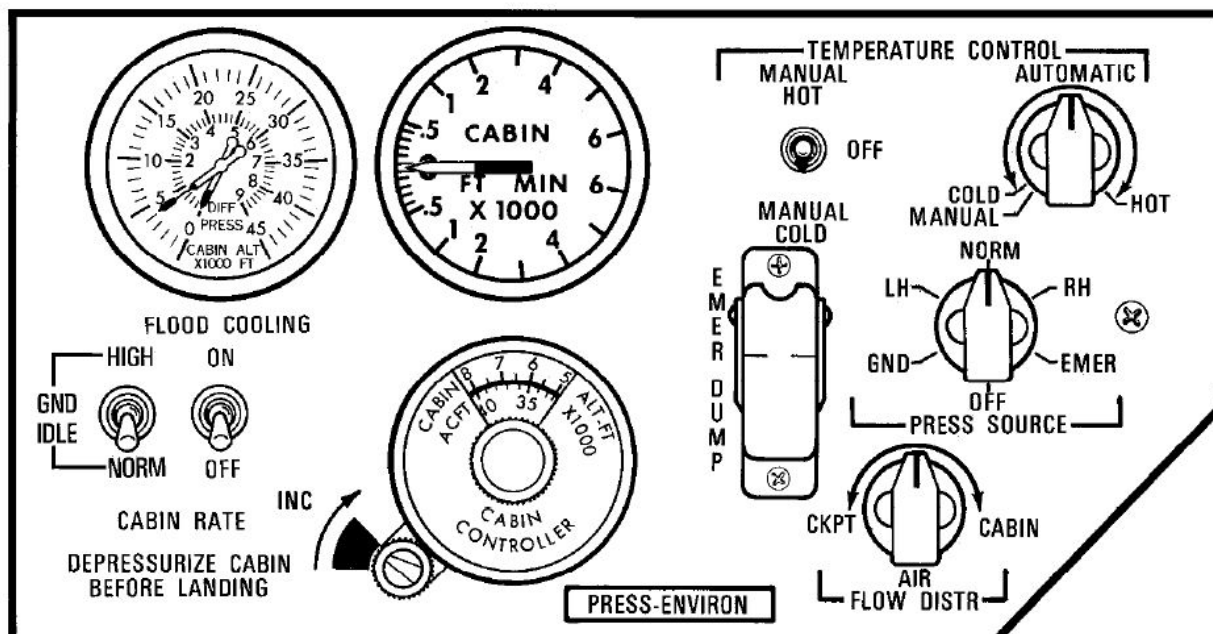


Figure 3. Pressurization - environmental control panel. (Courtesy of Textron Aviation)

2.2 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 ACM which conditions the air prior to distribution to the cabin. Cabin overhead and underfloor ducting is used to distribute the conditioned air. An optional freon air conditioning system is also available. Figure 4 shows the bleed air system schematic.

The ACM is located in the tailcone compartment and cools engine bleed air to approximately 2°C (35°F). Bleed air enters the ACM 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 ACM, pulls the fresh air over both heat exchangers and the precooler and dumps it overboard through a vent in the tailcone.

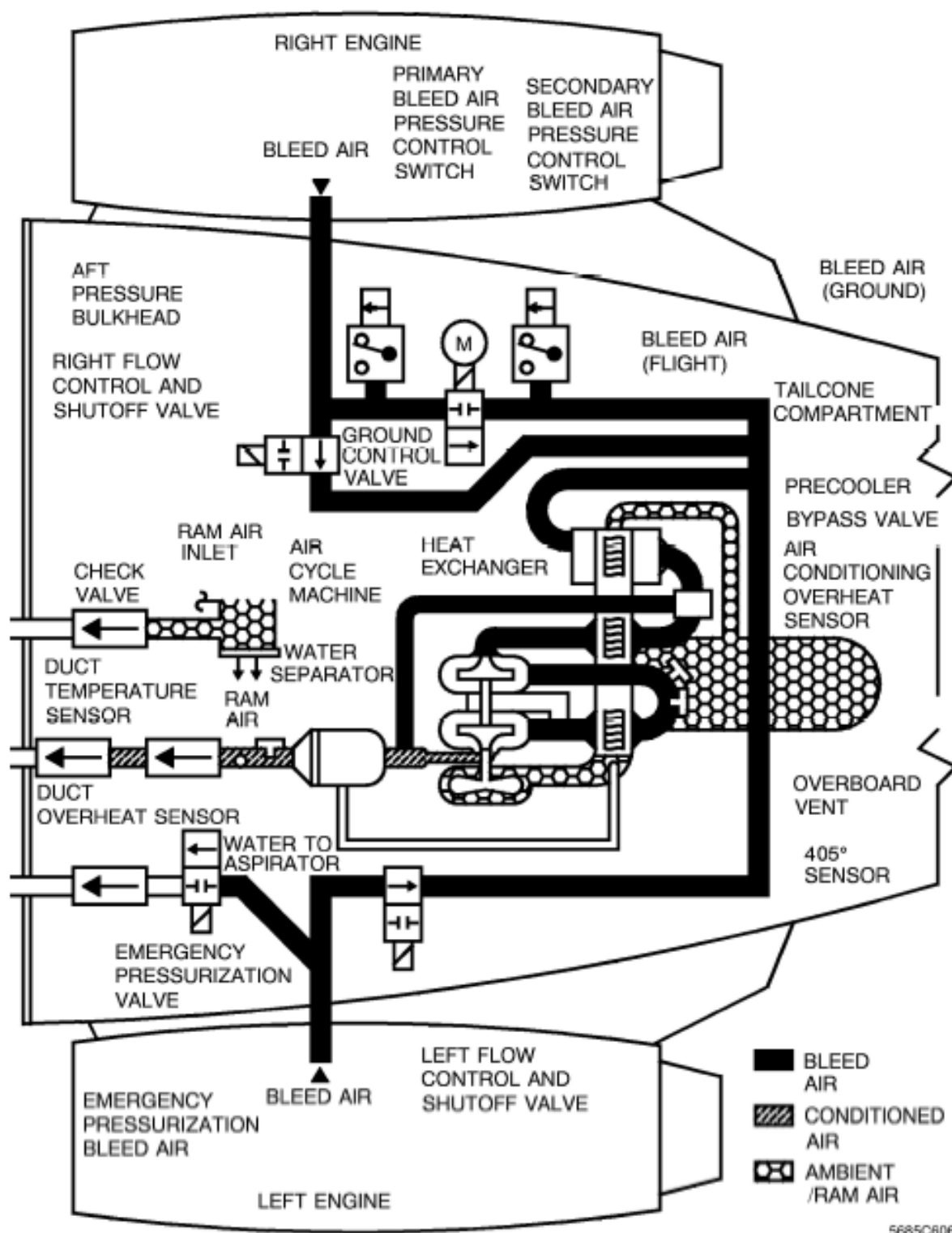


Figure 4. Bleed air system schematic. (Courtesy of Textron Aviation)

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 ACM. 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 ACM. 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 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 ACM to prevent excessively hot air from causing damage to the ACM 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 the airplane is in flight. This will secure the ACM 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 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.

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 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 410°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 to 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 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 Overhead (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.

2.3 CABIN AIR CONDITIONING

An optional vapor cycle air conditioner 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/BLO/OFF switch controls primary power to the system. The AC position turns on the compressor and the forward blower. The FWD BLOWER HI/LO switch controls the forward blower speed when the MODE switch is in AC or BLO. 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.

2.4 FLOOD COOLING SYSTEM

The Flood Cooling System is optional and 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 ensures against reverse flow when the system is not in use.

3.0 OXYGEN

3.1.1 General

The oxygen system provides supplementary oxygen for the cockpit sweep-on type masks and the passengers' continuous flow masks. It is not normally used since a cabin altitude of 8000 feet can be maintained at the maximum certified airplane altitude with normal pressurization system operation.

The oxygen system consists of the following components: Oxygen bottle, shutoff knob with pressure regulator, cylinder pressure gage, filler valve and cap, overboard pressure indicator, flow fuses, shuttle valve, oxygen control valve, cabin altitude switch, passenger solenoid valve, crew oxygen masks, passenger oxygen mask stowage/dropout boxes, and distribution lines. Figure 5 shows a schematic of the oxygen system.

3.1.2 Oxygen Bottle

The oxygen bottle is in the left side of the tailcone compartment and when fully charged, the 76.0 cubic foot bottle provides approximately one hour of oxygen for crew and six passengers. Duration for actual personnel aboard can be determined using the information in Figure 6.

Normal pressure for the system is 1600 to 1800 PSI. A pressure gage is located inside the tailcone baggage door and one is located on the far right side of the instrument panel.

The bottle assembly contains a pressure reducing valve, shutoff valve and provisions for external servicing. A green disc is installed in the end of the bottle overpressure vent line which is flush mounted on the lower left side of the aft fuselage approximately four feet aft of the tailcone access door. This disc, when ruptured, indicates bottle pressure has exceeded 2500 PSI and is empty. The oxygen bottle pressure is displayed on the right instrument panel. A view of the instrument panel and gage is shown in Figure 7.

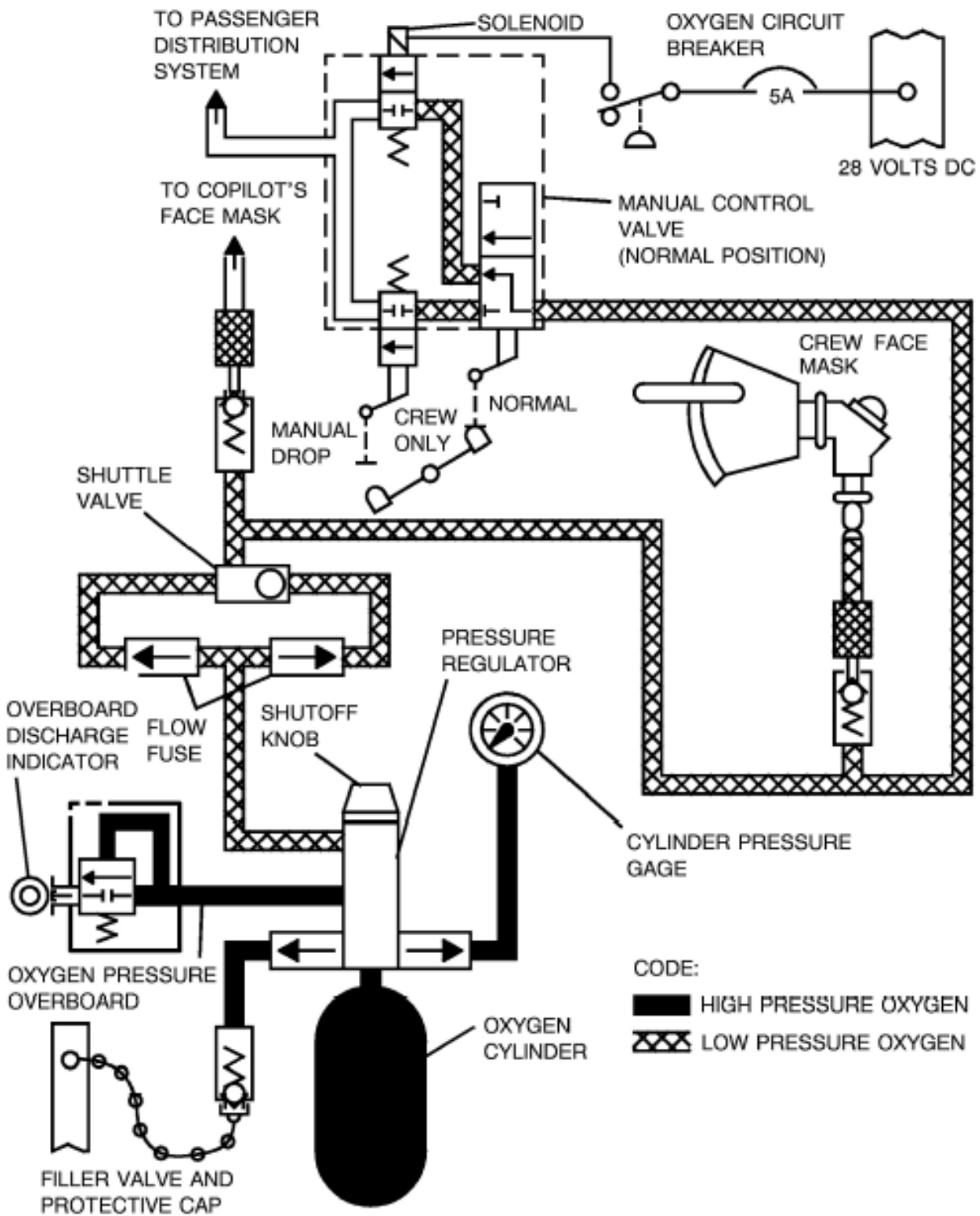


Figure 5. Oxygen system schematic. (Courtesy of Textron Aviation)

AVAILABLE TIME IN HOURS:MINUTES							
CABIN ALTITUDE	1 COCKPIT	2 COCKPIT	2 COCKPIT 2 CABIN	2 COCKPIT 4 CABIN	2 COCKPIT 6 CABIN	2 COCKPIT 8 CABIN	2 COCKPIT 10 CABIN
8,000	17:20	8:40	2:47	1:39	1:11	0:55	0:45
10,000	18:18	9:09	2:50	1:40	1:11	0:55	0:45
15,000	20:35	10:17	2:56	1:42	1:12	0:56	0:45
20,000	23:32	11:46	3:03	1:45	1:13	0:56	0:46
25,000	10:59	5:44	2:21	1:29	1:05	0:52	0:42
30,000	14:19	7:09					
35,000	19:22	9:41					
37,000	23:32	11:46					

NOTE

Cockpit masks are assumed to be at the normal setting at 20,000 feet with a respiratory rate of 10 liters per minute - body temperature pressure saturated and at 100% setting at and above 25,000 feet.

Figure 6. Available time for oxygen. (Courtesy of Textron Aviation)

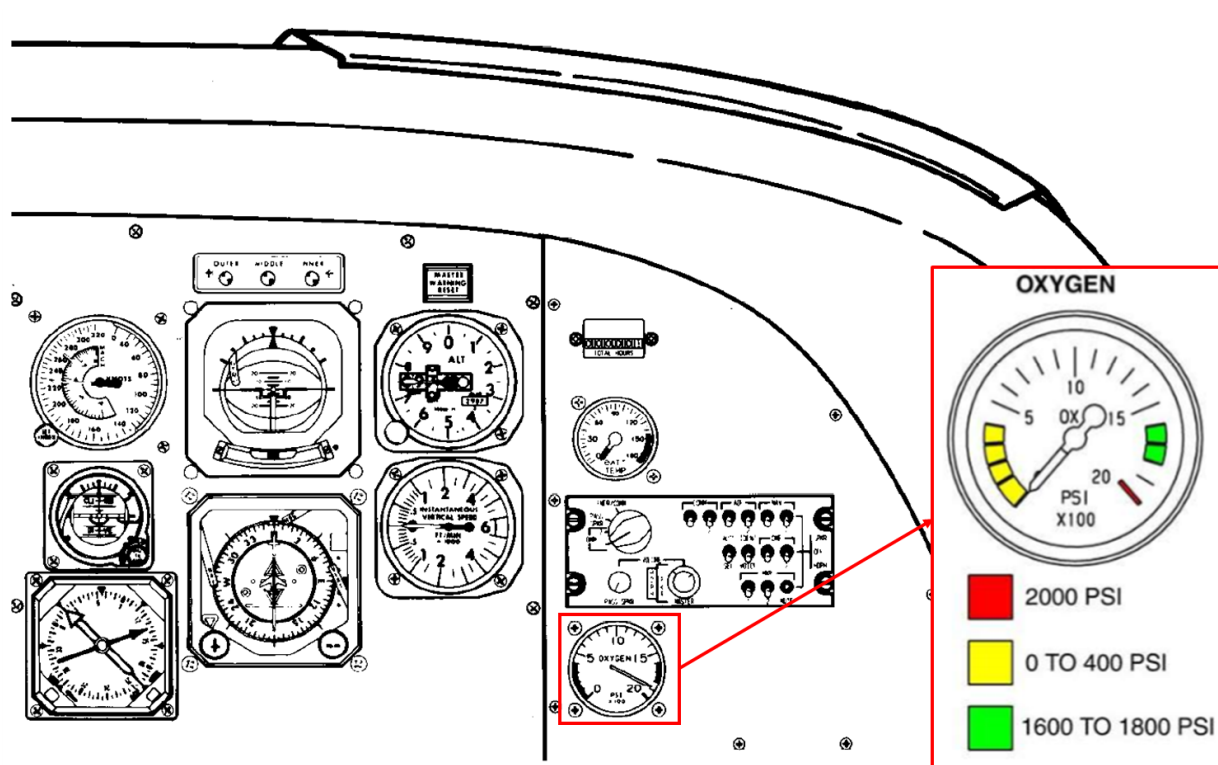


Figure 7. Airplane oxygen pressure gage. (Courtesy of Textron Aviation)

3.1.3 Oxygen System Controls

The left console contains the oxygen controls regulating flow to the passenger compartment (see Figure 8). An oxygen control valve labeled CREW ONLY, NORMAL and MANUAL DROP allows the pilot to select oxygen flow to the flight deck only (CREW ONLY position), or flow to both the passenger compartment and flight deck (NORMAL position). The MANUAL DROP position will allow the passenger oxygen masks to be manually deployed in the event of an emergency and the masks fail to

automatically deploy. A switch on both the pilot's and copilot's control panels, labeled MIC OXY MASK/MIC HEADSET, selects which microphone will be used.

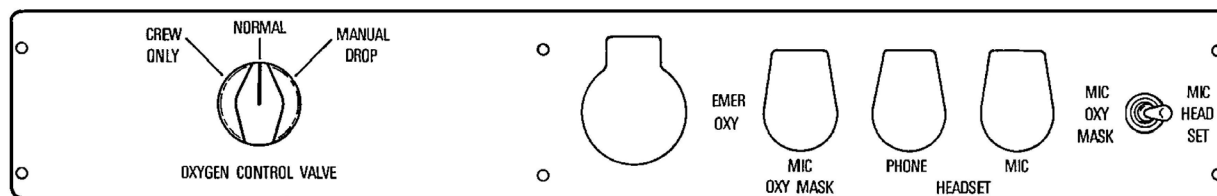


Figure 8. Pilot's side console oxygen control and outlets. (Courtesy of Textron Aviation)

3.1.4 Crew Oxygen Masks

The oxygen mask is a quick-donning sweep-on mask with a microphone and regulator attachment. The mask is a diluter demand type with pressure breathing available by selecting the EMER position. The crew member is assured that oxygen is being received when no restriction to breathing is present with the mask donned and in the 100 percent position.¹ Selection of the EMER position will provide a steady flow of pressurized oxygen in the face cone. Oxygen pressure to the mask may be verified by checking the transparent cylinder in the supply line for a green band. If no oxygen pressure is present the band will indicate red. To qualify as a quick-donning mask, the mask must be properly stowed in the retainer located just below each crew member's side window. To conserve oxygen when using the mask, the regulator may be set to normal if the cabin altitude is below 20,000 feet.

The 100 percent position should be selected when using an oxygen mask for smoke protection. The emergency position on the mask may be used if increased oxygen flow is desired. Use of the emergency position will result in diminished duration of oxygen supply.

A two-position toggle switch is provided on the pilot's and copilot's side consoles. The switch is marked MIC OXY MASK and MIC HEAD SET. Depressing the microphone button on the appropriate control wheel allows a crewmember to transmit through the headset microphone or oxygen mask microphone, whichever is selected.

¹ There are 5 crew masks certified for the 560 Citation V: 174252-06, 174252-16, 174252-17, MC10-15-109, MC10-16-101. The three 174252 masks are manufactured by BE Aerospace and they have a green in-line indicator on the hose to the mask to indicate oxygen is flowing. The MC10-15-109 and MC10-16-101 are manufactured by EROS and they use oxygen pressure to inflate the harness that holds the mask to the pilot's head.

3.1.5 Passenger Oxygen System

The passenger oxygen system consists of overhead oxygen mask stowage/dropout boxes and the oxygen supply lines. The passenger oxygen system is connected to the crew oxygen system. The crew and passenger oxygen systems are supplied oxygen from the same oxygen cylinder. The passenger system oxygen flow is controlled by an electrically operated solenoid valve, which is actuated by the altitude pressure switch. Both the valve and switch are in the crew oxygen system and are located inside the pilot's console. Oxygen pressure of 70 PSIG $\pm$ 10 PSIG is available at the solenoid valve. In the event of a possible decompression, the altitude pressure switch senses increasing altitude and actuates the solenoid valve between 12,900 to 14,100 feet. A manually operated valve (passenger oxygen manual valve) located on the top of the pilot's side console, is utilized to bypass the solenoid valve in the event of an electrical malfunction.

The supply system line is connected to a tee aft of the solenoid valve and routed to the cabin overhead panel. The line is routed through the panel and connects to the door actuator valve and oxygen service valve at each oxygen mask stowage/dropout box (see Figure 9). Each mask stowage/dropout box contains mask(s), oxygen service valve(s) and door actuator(s). The oxygen mask stowage/dropout box is installed in the overhead console. A mask is provided for each passenger seat. When the door actuator is energized, the stowage/dropout box opens releasing the mask. The actuator will exert a force of approximately 20 pounds at 70 PSI operating pressure. Oxygen will not flow from these masks until the lanyard on the respective mask has been pulled, removing the pintle pin from the valve. This conserves oxygen in the event all masks are not to be used. The mask is a constant flow type mask which means the passengers will receive the same quantity of oxygen at lower altitudes as they will at higher altitudes. The flow rate is 4.5 liters per minute. When the cabin altitude has reached approximately 8000 feet with electrical power available, the passenger solenoid valve will close, allowing passenger manifold oxygen pressure to bleed off. If electrical power is not available, the passenger manifold pressure can be shut off by closing the oxygen control valve by selecting the CREW ONLY position. As the oxygen pressure dissipates, the door actuators will retract, allowing mask stowage to be accomplished.

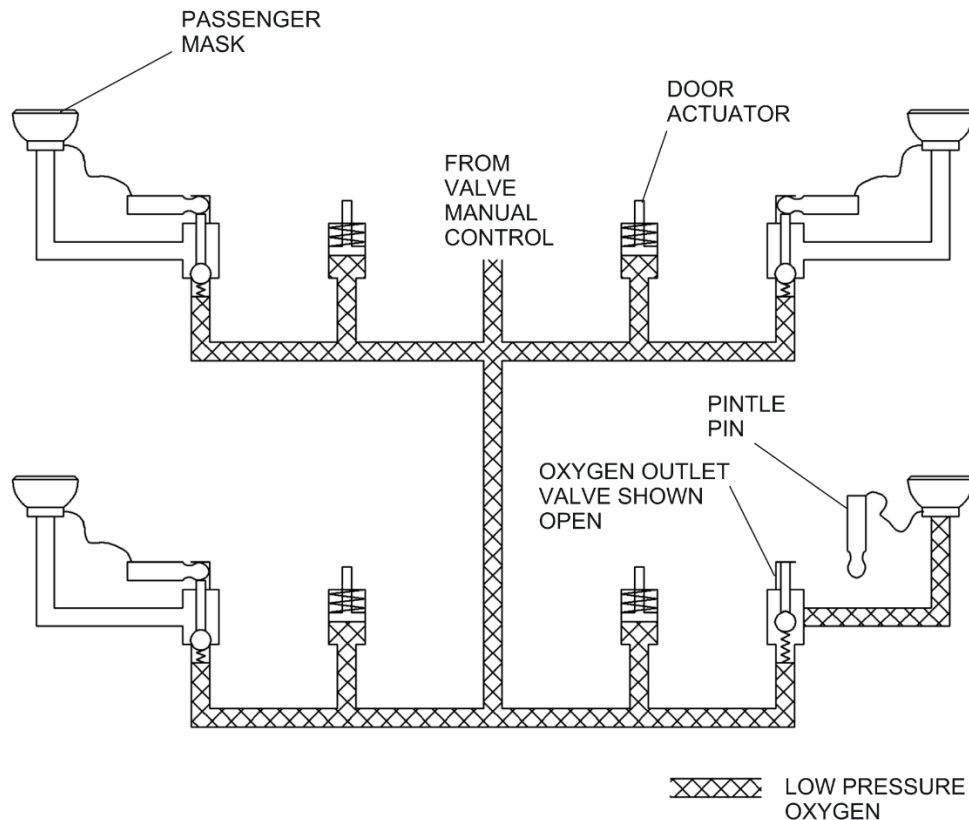


Figure 9. Passenger oxygen distribution schematic. (Courtesy of Textron Aviation)

4.0 Annunciator Panel

The annunciator panel (see Figure 10) is designed to provide the pilot with an easily interpreted display of both normal and abnormal system conditions. Two flashing master warning lights are used in conjunction with the panel to ensure rapid recognition of any red annunciator light. In addition, the master warning light will flash if both amber GEN OFF lights should illuminate.

The master warning lights can be reset by pressing either light. Resetting the master warning light rearms the system so that it will function should another failure occur.

The annunciator system is powered from the main direct current (DC) buses through the Warning Lights 1 and 2 circuit breakers on the left cockpit panel.

All system light bulbs can be tested by placing the rotary TEST selector on the left instrument panel to the annunciator (ANNU) position. This will illuminate all lights and cause the master warning lights to flash.

Burned out bulbs can be replaced by pushing in the light assemblies to the left and right of the failed bulb; then use a tool to remove the assembly with the burned out lamp.

If the MASTER WARNING light illuminates in a steady mode, it indicates that there has been a loss of power to the annunciator panel from either the left or right DC electrical bus.

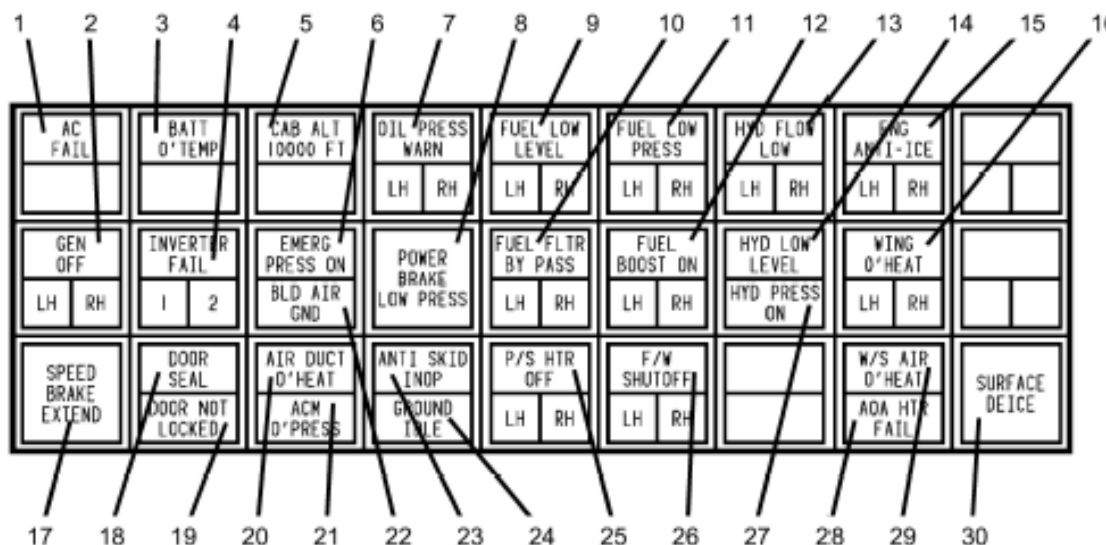


Figure 10. Annunciator panel. (Courtesy of Textron Aviation)

Table 1. Annunciator panel light descriptions.

ID	Name	Description
1	AC FAIL	The red alternating current fail light advises that the AC power bus voltage is above 130 VAC or below 90 VAC. Illumination of light also triggers the master warning system which will illuminate the master warning light. The AC FAIL light will remain illuminated until the MASTER WARN light is reset, even if the fault is momentary.
2	GEN OFF LH RH	The amber generator OFF light advises that left and/or right generator is not connected to the airplane bus. Illumination of both left and right lights will trigger the master warning system which will illuminate the master warning light.
3	BATT OTEMP	The red battery overtemperature light will illuminate with a steady light at temperatures over 145°F and will flash at temperatures over 160°F. Illumination of the light also triggers the master warning system which will illuminate the master warning light.
4	INVERTER FAIL 1 2	The amber inverter fail light advises that the number 1 or number 2 inverter output voltage is above 130 VAC or below 90 VAC. The failure of either inverter also triggers (AC FAIL). Resetting the master warning reset switch will extinguish the AC FAIL annunciation unless both inverter lights are illuminated.
5	CAB ALT 10,000 FEET	The red cabin altitude light advises that the cabin pressure altitude is above 10,000 feet. Illumination of the light also triggers the master warning system which will illuminate the master warning light.

ID	Name	Description
6	EMERG PRESS ON	The amber emergency pressurization on light advises that emergency pressurization has been manually selected or automatically activated by an air cycle machine overheat.
7	OIL PRESS WARN LH RH	The red oil pressure warning light advises that the oil pressure is below safe limits (40 PSI) in left or right engine. Illumination of light also triggers the master warning system which will illuminate the master warning light.
8	POWER BRAKE LOW PRESS	The amber power brake low pressure light advises that the power brake hydraulic pressure is low.
9	FUEL LOW LEVEL LH RH	The amber fuel low level light advises that the fuel quantity in left and/or right tanks is below approximately 185 pounds or less.
10	FUEL FLTR BYPASS LH RH	The amber fuel filter bypass light advises that bypass of the left and/or right fuel filter is impending.
11	FUEL LOW PRESS LH RH	The amber fuel low pressure light advises that the fuel pressure is low in left and/or right systems.
12	FUEL BOOST ON LH RH	The amber fuel boost ON light advises that electric power has been applied to the left and/or right fuel boost pump.
13	HYD FLOW LOW LH RH	The amber hydraulic flow low light advises that left and/or right hydraulic system flow is below approximately 0.35 to 0.55 gallons per minute.
14	HYD LOW LEVEL	The amber hydraulic low level light advises that the fluid in the hydraulic reservoir is low.
15	ENG ANTI-ICE LH RH	The amber engine anti-ice light advises that the left and/or right engine inlet, stator, or inboard wing anti-ice has failed.
16	WING O'HEAT LH RH	The amber wing o'heat light advises that inboard leading edge temperature is above 160° F.
17	SPEED BRAKE EXTEND	The white speedbrake extend light advises that the left and right speedbrakes are fully extended.
18	DOOR SEAL	The amber door seal light advises that the door seal is not inflated.
19	DOOR NOT LOCKED	The amber door-not-locked light advises that the cabin door, aft compartment access door lock, or either nose baggage door lock is/are not locked.
20	AIR DUCT O'HEAT	The amber air duct overheat light advises that the ventilation duct temperature exceeds safe limits.
21	ACM O'PRESS	The amber air cycle machine overpressure light advises that the air cycle machine pressure is over 42 psi.
22	BLD AIR GND	The amber bleed air light advises that the high flow rate of bleed air has been selected from the right engine for ground operation of the air conditioner.
23	ANTI_SKID INOP	The amber inoperative light advises that the antiskid system is inoperative.
24	GROUND IDLE	With airplane on the ground, the amber ground idle light advises that the ground idle switch is in normal (NORM) position.
25	P/S HTR OFF	The amber pitot/static heater OFF light advises that the left and/or right pitot heat is off.
26	F/W SHUT OFF LH RH	The amber firewall shutoff light advises that the left and/ or right fuel and hydraulic shutoff valves are closed.
27	HYD PRESS ON	The amber hydraulic pressure ON light advises that the hydraulic system is pressurized.

ID	Name	Description
28	AOA HTR FAIL	The amber angle-of-attack heater fail light advises that the heating element in the probe is inoperative.
29	W/S AIR O'HEAT	The amber windshield air overheat light advises that the bleed air to the windshield exceeds safe temperature limits.
30	SURFACE DEICE	The white surface deice light advises that the surface deice boots are inflated over 21 psi.

E. DETAILS OF THE INVESTIGATION

1.0 Wreckage and Impact Information

The airplane impacted steep rocky terrain about 1.5 miles north of the Montebello VOR (see Figure 11). The debris field was condensed in a very small area consistent with the aircraft impacting the ground at a nearly vertical angle. The near vertical angle was determined based on the angle that the tree limbs surrounding the debris field were severed. The wreckage was extremely fragmented and scattered around a main crater. A post impact fire occurred. One engine was generally intact and was located approximately 100 feet downhill from the impact crater. The other engine was fragmented and located in the debris field. The following components were located in the debris field: left main landing gear assembly, both thrust reverser structure, tail structure with a portion of the elevator, a section of rudder, pieces of both ailerons on opposite sides of debris field, flap tracks, four wing attachment points, pieces of control cable from the tail, pieces of avionics boxes, seat frames and seat track, wing skin and portions of the wet wing structure.

The cockpit voice recorder was not located. No components were removed from the scene by the NTSB.



Figure 11. Accident scene.

The wreckage was recovered by Anglin Air Recovery Services and shipped to their facility for further examination.

2.0 Wreckage Examination

The group met at Anglin Air Recovery Services' facility in Clayton, DE on 6-7 September 2023 to examine the wreckage recovered from the accident site. The group examined eighteen bags of wreckage looking for the CVR, pressurization, bleed air, oxygen, and flight control components. The aircraft data plate was recovered (see Figure 12). The wreckage was highly fragmented (see Figure 13). No components of the CVR were found.



Figure 12. Aircraft data plate.



Figure 13. Representative picture of wreckage debris.

2.1 Aircraft Structure

The entirety of the airplane was heavily fragmented and thermally damaged from a post-accident fire. Portions of the nose compartment, cockpit, cabin, both wings, and empennage were observed. Several avionics units from the cockpit were destroyed and unidentifiable. A portion of the throttle quadrant was located. A portion of the left and right elevator, a section of rudder, portions of speed brake panels, fragments of both ailerons, all eight flap tracks (see Figure 14), and seven of eight wing attachment points were located in the wreckage. A Garmin transponder was located. Four of the 8 main door locking pins were located. In addition, three of the four door latches were located.

2.2 Flight Controls

All four trim actuators were located in the wreckage. The trim actuators are mechanical actuators and the actuator positions would not change during the crash.² One elevator trim actuator remained attached to the elevator. The elevator bellcrank, elevator pushrods, both elevator surfaces, some pieces of the vertical tail and fragments of rudder surface, rudder bellcrank, and rudder trim actuator were located in the wreckage.

Two of the three autopilot servo drums were located in the wreckage. The motors for the autopilot servos were not attached to the drum assemblies. All eight flap tracks that attach to the flap surfaces were located. Several bell cranks and pushrods were located in the wreckage. Portions of flight control cables were located but their original locations could not be determined.

The left elevator trim was measured at 1.7 inches, which corresponds to 5 degree tab up trim (see Figure 15). The right elevator trim actuator was 1.8 inches, which corresponds to 6.5 degrees tab up (see Figure 16). The right elevator trim actuator rod was bent 90 degrees and sustained heavy impact related damage.

The rudder trim actuator was measured at 1.93 inches, which corresponds to 5 degree trim tab left (see Figure 17). The aileron trim actuator 1.81 inches, which corresponds 5 degree trim tab down (see Figure 18). The aileron trim tab is installed on the left aileron.

² All the trim tab actuators incorporate two internally threaded screws, two externally threaded screws and thrust bearings. Sprockets are mounted on one end of each internally threaded screw and are connected together with a chain to drive the two externally threaded screws in unison.



Figure 14. Photo of the flap tracks.



Figure 15. Photos of left elevator trim actuator.



Figure 16. Photos of right elevator trim actuator.



Figure 17. Photo of rudder trim actuator.



Figure 18. Photo of aileron trim actuator.

2.3 Landing Gear

The left main landing gear was located (see Figure 19). One main landing gear wheel and one main landing gear actuator were located but their position could not be determined.



Figure 19. Left main landing gear.

2.4 Oxygen System Components

The oxygen high pressure relief valve overboard discharge indicator and a fragment of structure was located (see Figure 20). The oxygen high pressure relief valve overboard discharge indicator was intact. Bleed air flow valve and sections of ducting were located in the debris.

Two passenger oxygen masks were located in the debris. They remained attached to their respective box assemblies next to the oxygen shutoff valve. The unit was found loose in the debris and sustained heavy impact and thermal damage. One oxygen mask stowage/dropout box assembly and its oxygen shutoff valve were found capped with a dust cap (see Figure 21), rather than an approved AN cap (see Figure 22). No other major portions of the oxygen or pressurization system were located in the debris.



Figure 20. Photo of oxygen high pressure relief valve overboard discharge indicator.



Figure 21. Photo of passenger oxygen mask stowage/dropout box assembly with dust cap installed.



Figure 22. Photo of passenger oxygen mask stowage/dropout box assembly with AN cap installed.

2.5 Engines

The Pratt & Whitney Canada JT15D-5 turbofan engines sustained heavy impact and thermal damage consistent with post-impact fire. They had separated from the airframe and were located in the debris field. The engine data plates were not recovered, therefore the original positions of the engines on the aircraft could not be identified. As a result, they were labeled Engine A / B, which do not correspond to any position on the aircraft. The following are observations of the recovered engine components.

The single-stage low-pressure compressor (LPC) booster and fan assembly was located in the debris. It was not determined which engine it belonged to. All but one fan blade was fractured at the root the remaining blade was fractured at the mid-span and bent in the opposite direction of rotation. About half the LPC blades were bent

opposite the direction of rotation. The other half of the blades were missing. Some of the remaining blades were displaced aft. The low pressure (LP) shaft was fractured.

2.5.1 Engine A

The following observations of engine A (see Figure 23) were noted:

- Aft looking forward, all the second stage low pressure turbine (LPT) blades were fractured at their platforms. Scoring was observed on the second stage blade tip shroud (see Figure 24).
- The second stage LPT vanes were present. Impact marks were located on the trailing edge nearly the full 360 degrees around. Some vanes were bent with impact marks.
- Looking through the second stage LPT nozzle vanes, all first stage LPT blades were fractured at their platforms. The first stage LPT nozzle was not visible so it could not be assessed. The engine was not disassembled so the high pressure turbine (HPT) was not inspected.
- The compressor diffuser was buckled, and rotational scoring was observed. Both HP and LP shafts were fractured and separated (see Figure 25).
- The high pressure compressor (HPC) impeller was separated and showed signs of rotational scoring. About 1/5 of the impeller exducer was fractured and was missing. The majority of the impeller blades were fractured and were missing at the root. Some remaining blades were bent over, opposite direction of rotation. The bevel gear for the accessory drive was fractured (see Figure 26).
- The impeller shroud was deformed and evidence of 360 degree rotational scoring and blueing was observed (see Figure 27).



Figure 23. Photo of engine A.

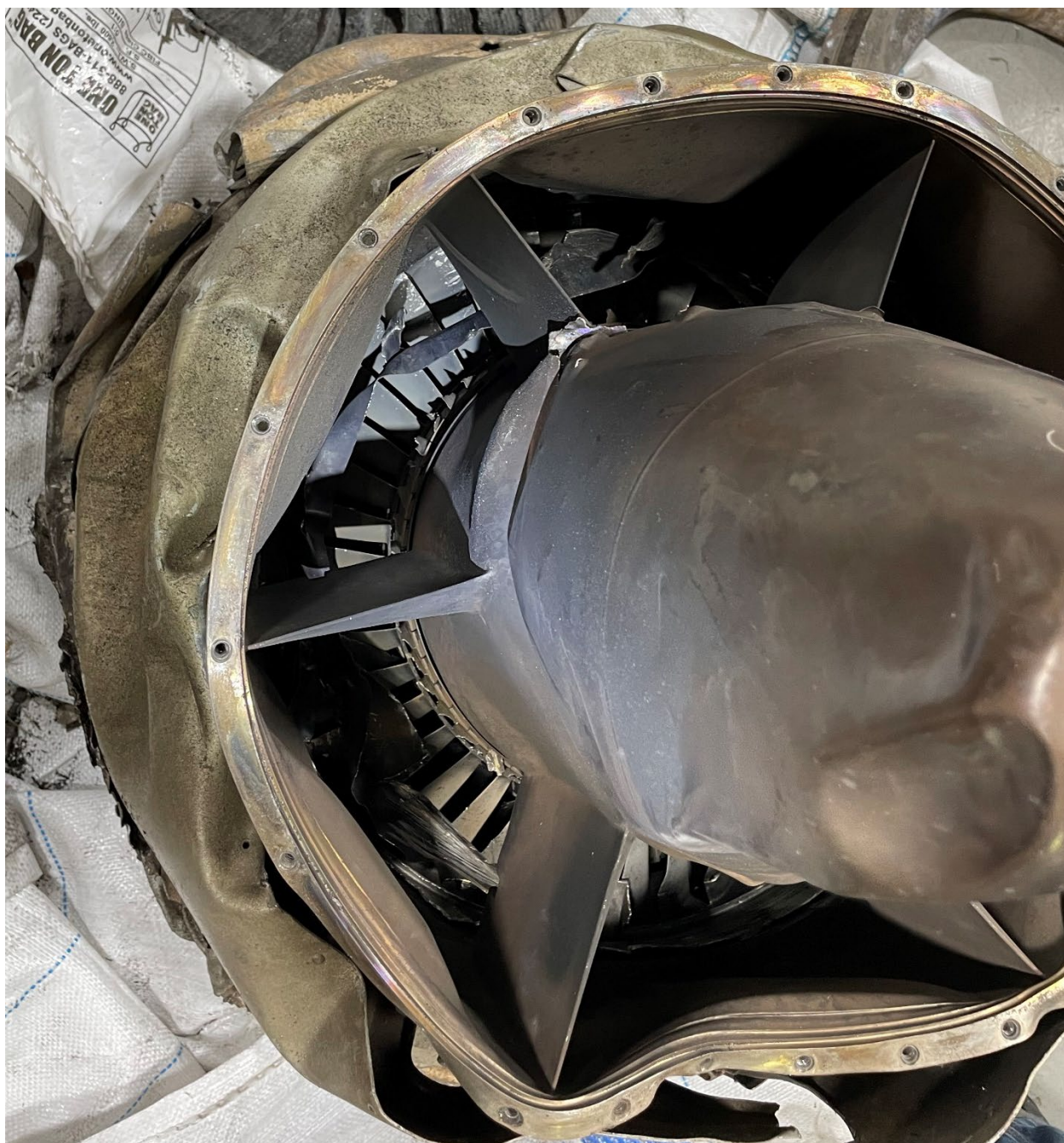


Figure 24. Photo of engine A second stage LPT.



Figure 25. Photo of engine A compressor diffuser.



Figure 26. Photo of engine A compressor impeller.



Figure 27. Photo of engine A HPC impeller shroud.

2.5.2 Engine B

The following observations of engine B (see Figure 28) were noted:

- Aft looking forward, the exhaust nozzle was attached and deformed. There were holes observed on the exhaust nozzle, with evidence of foreign material and melted deposits near the holes (see Figure 29).
- The exhaust center cone and support struts were present.
- The second stage LPT blades were fractured and separated at the platforms (see Figure 30). The LPT module appeared displaced aft. About half of the second stage LPT vanes were fractured and exhibited trailing edge impact damage. First stage LPT blades were fractured at the platform or were separated and missing.

- The HPC impeller remained on the shaft. The majority of the blades were fractured at the root and missing. The remaining blades were bent opposite direction of rotation (see Figure 31).
- The HP and LP shafts were fractured forward of the impeller.
- The engine case had partially separated due to impact related damage, allowing a view of the combustor and the HPT rotor (see Figure 32). The HPT blades were missing.
- The HPC impeller shroud was deformed. It showed marks of rotational scoring (see Figure 33).



Figure 28. Photo of engine B.



Figure 29. Photo of engine B exhaust nozzle.



Figure 30. Photo of engine B second stage LPT.



Figure 31. Photo of engine B compressor impeller.



Figure 32. Photo of engine B case separation.



Figure 33. Photo of engine B impeller shroud.

3.0 Maintenance Records

The most recent aircraft logbooks could not be located. The logbooks were likely on the aircraft because the return flight was planned to be to a maintenance facility in Florida.

The aircraft was manufactured in 1990. According to an FAA Application for Export Certificate of Airworthiness, on October 1, 2015, the airplane was sold and exported to Venezuela. It was re-issued an airworthiness certificate on February 3, 2023. A Conformity Inspection Record (FAA Form 8100-1) was completed with all items marked as satisfactory.

According to a Major Repair and Alteration FAA Form 337, on April 11, 2023, a Garmin GTN-750 Com/Nav/GPS, dual GAD 42 adapters, and GTX 345 and GTX 335 transponders were installed in accordance with Supplemental Type Certificate (STC) ST01691WI. In addition, an ART-2000 and DME-42 was installed.

The following information was taken from the Continuous Airworthiness Maintenance Program (CAMP) records of the aircraft. As of 27 Jan 2023, the aircraft had accumulated 10,409.9 flight hours and 9700 flight cycles. Engine 1 (SN PCE-108187) had accumulated 10,344.2 flight hours and 9618 cycles and engine 2 (SN PCE-108185) had accumulated 10,410.5 flight hours and 9723 cycles.

The last entry in the CAMP Discrepancy Report was on 12-December-2017.

Table 2 lists the maintenance items that were overdue on the date of the accident according to CAMP. Table 3 lists the oxygen system components or test records contained in CAMP. Table 4 lists the air conditioning components or test records contained in CAMP.

Table 2. Overdue maintenance items from CAMP.

Description	Interval	Last completed	Due
Capacity check main ship battery	Every 3 months	25 Jan 2023	30 April 2023
Emergency locator transmitter beacon battery	Every 60 months	28 Nov 2017	27 Nov 2022
Oxygen mask – co-pilot	Every 72 months	12 May 2017	31 May 2023
Perform Vapor Cycle Cooling System Hour Meter Check	Every 300 hours	19 Nov 2015 (9,775,4)	10,025.4
Perform 500 Compressor Hour Maintenance Check on Vapor Cycle Cooling System	Every 500 hours	19 Nov 2015 (9,775,4)	10,225.4

Table 3. Selected oxygen system components or test records from CAMP.

Description	Interval	Last completed	Due
Hydrostatic Test Oxygen Cylinder (Manufacture Date 3/4/2016)	Every 180 Months	09 Dec 2021	31 Mar 2031
Co-Pilot Oxygen Mask	Every 72 months	12 May 2017	31 May 2023
Pilot Oxygen Mask	Every 72 months	08 Feb 2021	28 Feb 2027
Oxygen Supply Regulator	N/A	23 Mar 2002	N/A
Inspect Oxygen System	Every 36 months or 1200 hours	17 Dec 2021	31 Dec 2024
Inspect Passenger oxygen Masks	Every 12 months	25 Jan 2023	31 Jan 2024
Functional Test Oxygen System, Flow Fuses and Shuttle Valves	Every 36 months or 1200 hours	17 Dec 2021	31 Dec 2024
Functional Test Oxygen System	Every 36 months or 1200 hours	17 Dec 2021	31 Dec 2024
Operational check crew oxygen mask inspection, flow check and microphone	Every 36 months or 1200 hours	17 Dec 2021	31 Dec 2024

Table 4. Selected air conditioning components or test records from CAMP.

Description	Interval	Last completed	Due
Overhead Cabin Fan	1000 hours	10,300.4	11,300.4
Cockpit Defogger Fan	3500 hours	12 May 2015	13,265
Air Cycle Machine	5000 hours	10 Jan 2011 (9,258.8 hours)	14,258.8
Check Air Cycle Machine	150 hours	17 Dec 2021 (10,409.9)	10,559.9 – 10,589.9
Perform 12 Month Maintenance Check of Vapor Cycle Cooling System	Every 12 Months	25 Jan 2023	31 Jan 2024
Inspect Humidity Regulator	Every 24 month or 300 hours	17 Dec 2021	31 Dec 2023 or 10,709.9
Operational Check Environmental System	Every 36 month or 1,200 hours	17 Dec 2021	31 Dec 2024 or 11,609.9
Operation Test Emergency Pressurization Valve	Every 24 month or 300 hours	17 Dec 2021	31 Dec 2023 or 11,709.9
Operational Test Flow Control Shutoff and Check Valves	Every 36 month or 1,200 hours	17 Dec 2021	31 Dec 2024 or 11,609.9
Leak Check Tailcone Bleed Air Lines	Every 36 month or 1,200 hours	17 Dec 2021	31 Dec 2024 or 11,609.9
Operational Check Vertical Scale Instrument Panel Cooling Fan	Every 36 month or 1,200 hours	17 Dec 2021	31 Dec 2024 or 11,609.9
Operational Check Avionics Bay Cooling fan	Every 36 month or 1,200 hours	17 Dec 2021	31 Dec 2024 or 11,609.9
Operational Check Pressurization	Every 36 month or 1,200 hours	17 Dec 2021	31 Dec 2024 or 11,609.9
Functional Test Barometric Cabin Altitude Pressure Switch	Every 36 month or 1,200 hours	17 Dec 2021	31 Dec 2024 or 11,609.9
Operational Check Pressurization System	Every 36 month or 1,200 hours	17 Dec 2021	31 Dec 2024 or 11,609.9
Functional Test Outflow Valve Cabin Altitude Limiter	Every 36 month or 1,200 hours	17 Dec 2021	31 Dec 2024 or 11,609.9
Change Oil Air Cycle Machine	Every 600 hours	19 Jul 2018	10,934.6
Clean/Replace Pressurization Controller	Every 36 month or 1,200 hours	17 Dec 2021	31 Dec 2024 or 11,609.9
Replace Pneumatic Relay Cartridge Filter	Every 36 month or 1,200 hours	17 Dec 2021	31 Dec 2024 or 11,609.9
Clean/Replace Solenoid Valve Filter	Every 36 month or 1,200 hours	17 Dec 2021	31 Dec 2024 or 11,609.9

The most recent maintenance records were a discrepancy report from a visual inspection completed on 10 May 2023 by Flight Path Aviation Services. A list of the discrepancies that were noted is contained in Table 5. When the discrepancies listed in Table 5 were documented, the owner declined to have them addressed. The nose tire was replaced on 11 May 2023. In addition, there was a discrepancy “the wiring on the flight director and alt select was intermittent”. This resulted in replacement of the flight director.

Table 5. Visual walk-around discrepancy list generated on 10 May 2023.

Nose wheel tire chunk missing
Old proseal around leading edge that should have been removed during inspection
Left wing boot has multiple boot patches that are not within serviceable limits
Paint on ailerons show signs of multiple cracks
Left engine started generator shroud loose and moveable by hand
Left engine started generator cooling duct torn beyond serviceable limits
Multiple panels installed with old, stripped screws
Aft baggage door hinge completely broken at risk of falling off
Aft baggage door seal torn
Multiple corrosion spots on left and right elevators and stabilizer
Emergency exit door seal sticking out of airplane
Broken ground strap on nose wheel
Major fuel leaks on bottom of left and right wings (previously marked with red sharpie)
Comm 1 antenna broken near static wick
Multiple corrosion spots on aircraft belly
Fire bottle squibs not safety wired
Humidity regulator improperly installed
Hydraulic system overserviced
Cockpit voice recorder not safety wired
Thrust reverser rods dry, questions if they were serviced
Cockpit removeable fire extinguisher empty, not serviceable
No life vests installed
No first aid kit installed
Cabin temperature sensor laying on the floor, not properly secured
Bluewater toilet improperly installed, strong urine scent under lavatory
Screws missing out of pilot/ co-pilot circuit breaker panels

The discrepancy “Humidity regulator improperly installed” was clarified in NTSB Memorandum for Record of Mr. Smith and Mr. McMillan. “Mr. McMillan additionally reported that he observed discrepancies with the environmental system and the ACM. He observed that the aspirator line was not connected. He explained that the ACM brings air into the cabin from the engine bleed air, and the aspirator line connects to the humidity regulator. He observed that the aspirator line was not hooked up and its connection area was missing its plastic fitting. He elaborated that the fitting was missing, and that in his experience, the fitting is a plastic piece that can often be found old and brittle. It is a plastic fitting that is also difficult to find as a replacement part in his experience. He explained that if that line is not hooked up, there will be a leak in the ACM and you can hear a difference in its running performance, when the line is connected, versus when it is not connected.”

The aircraft was taken back to Flight Path Aviation Services on 01 June 2023 because the pilot had reported that there was a problem with the newly installed avionics. The owner understood that there was a cooling fan issue. After the airplane would fly for a few hours, the avionics would go out (shut off) and the radios were intermittent. Per NTSB Memorandum for Record of Mr. Smith and Mr. McMillan, “the cockpit and the Garmin displays were so hot, they could not touch them”. When the mechanic looked behind the newly installed avionics, he discovered that the avionics cooling fan, that would be a part of standard equipment as part of the airframe, had

been removed. Given that their shop did not install the new avionics, the mechanic's knowledge was limited in the installation of the new avionics. There was little room for the avionics cooling fan, and the accident pilot was informed the fan would need to be added behind the panel, and the panel would need to be redesigned. The work was scheduled to commence the week of June 12, 2023.

According to the mechanics from Flight Path Aviation Services, no work orders or maintenance endorsements were created from the activities on June 2, 2023, given they only visually looked at components and did not repair or replace any components on that day. During the June 2, 2023, inspection, Mr. Smith observed that the airplane looked the same as it did on 10 May except that the pilot side oxygen mask was not installed. Items mentioned in NTSB Memorandum for Record of Mr. Smith and Mr. McMillan are listed in Table 6. In addition, Mr. McMillan observed that the oxygen levels on the airplane were at their minimums before the aircraft departed.

Table 6. Mechanic observations on 02 June 2023.

Old proseal around leading edge that should have been removed during inspection
Multiple panels installed with old, stripped screws
Emergency exit door seal sticking out of airplane
No pilot oxygen mask installed
Oxygen levels at minimum servicing levels

Note that the Airplane Flight Manual (AFM) preflight cockpit inspection states "Check that oxygen masks, headsets, microphones and the pilot's checklist are on board.". In addition, the before starting engines checklist has the following step: "Oxygen System - CHECK and STOW (With regulator set at 100% and EMER. Verify green band visible in O2 supply line). Check quantity gage at 1600-1800 PSI and crew masks connected to side console outlets. Pilot's side console oxygen control valve properly positioned to NORMAL. Caution should be exercised as inadvertently placing the oxygen control valve to MANUAL DROP will result in deployment of the cabin masks. The crew masks must be stowed in the quick donning hook and set on 100% for flight above FL 250."

Submitted by:

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