

CESSNA P210 EXHAUST SYSTEM

The exhaust system was constructed of 321 stainless steel. The exhaust system consisted of two exhaust stack assemblies, one for the left and one for the right bank of cylinders. These exhaust stack assemblies were joined together to route the exhaust from all cylinders through the waste-gate or turbine. The three risers on the left bank of cylinders were joined together into a common pipe to form the left stack assembly. The risers on the cylinders were connected to a common pipe to form the right stack assembly. The right stack assembly connected to the left stack assembly at the front of the engine.

Mounting pads for the wastegate and turbine were provided on the right stack assembly. From the exhaust port of the turbine, a tailpipe was routed overboard through the lower fuselage. The exhaust port of the wastegate was routed into the tailpipe so the exhaust gas could be expelled from the system when not needed at the turbine. The wastegate was actuated by the wastegate actuator which, in turn, was controlled by the wastegate controller.

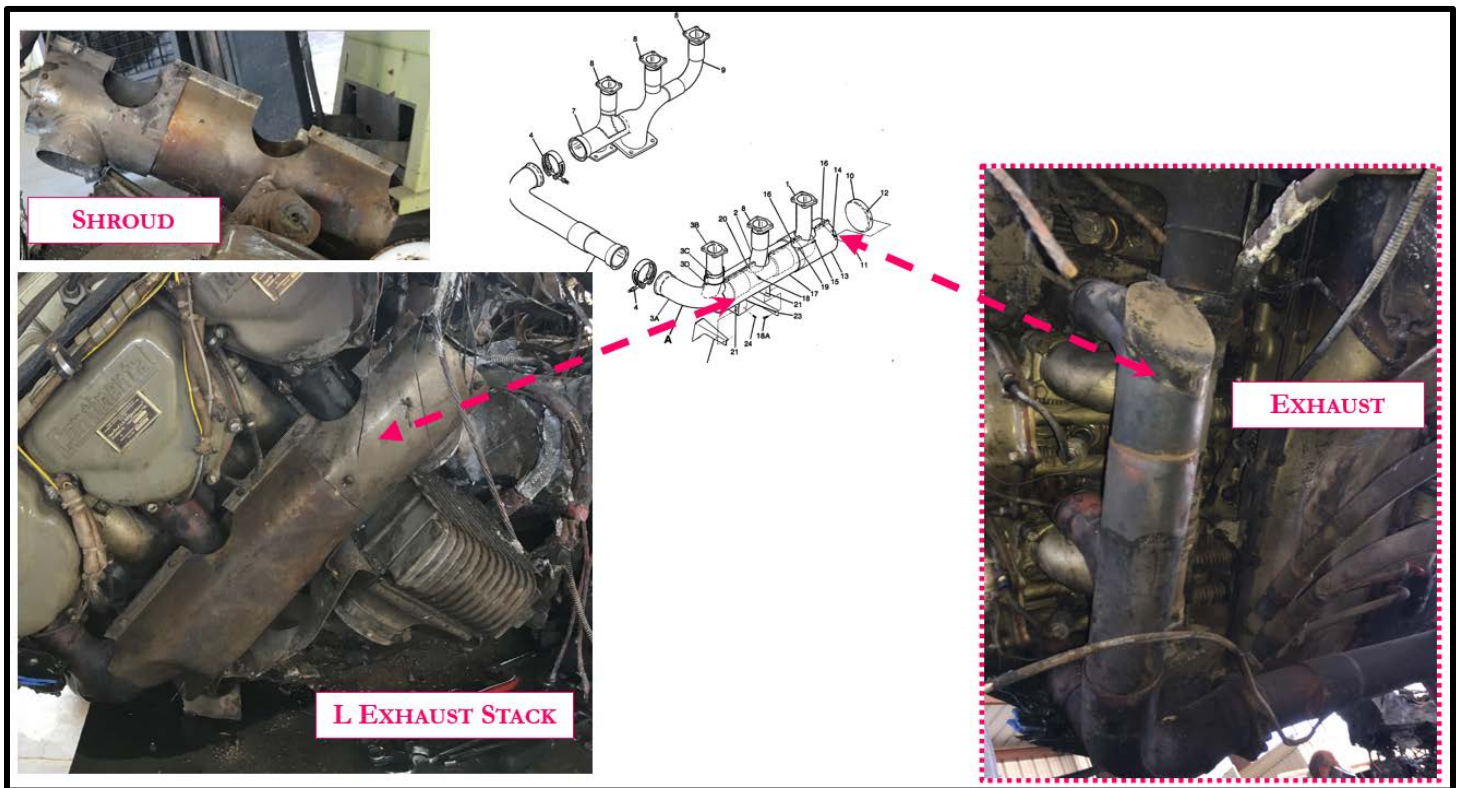


Figure 1: Exhaust System

PRESSURIZATION SYSTEM DESCRIPTION

The airplane was equipped with a cabin pressurization system that utilized bleed air from the engine turbocharger. The system operated in conjunction with the cabin heating, ventilating and defrosting system by using the same ducts and outlets in the cabin.

PRESSURIZATION ON

When the pressurized mode is selected by the pilot, heated bleed air from the turbocharger compressor is ducted through a sonic venturi (flow limiter) to the heat exchanger. If the heat control in the cockpit is OFF (cabin heat control pushed full in), ram air from an air scoop on the lower left side of the engine cowling is directed through the heat exchanger, cooling the bleed air. If the heat control in the cockpit is ON the cabin heat control is pulled full aft, which closes the heat exchanger to cool ram air flow, and instead, allows heated ram air to pass through the heat exchanger; this heated ram air is heated by passing through a shroud over the engine left exhaust manifold. Bleed air is, therefore, further heated by this hotter air as it flows through the heat exchanger.

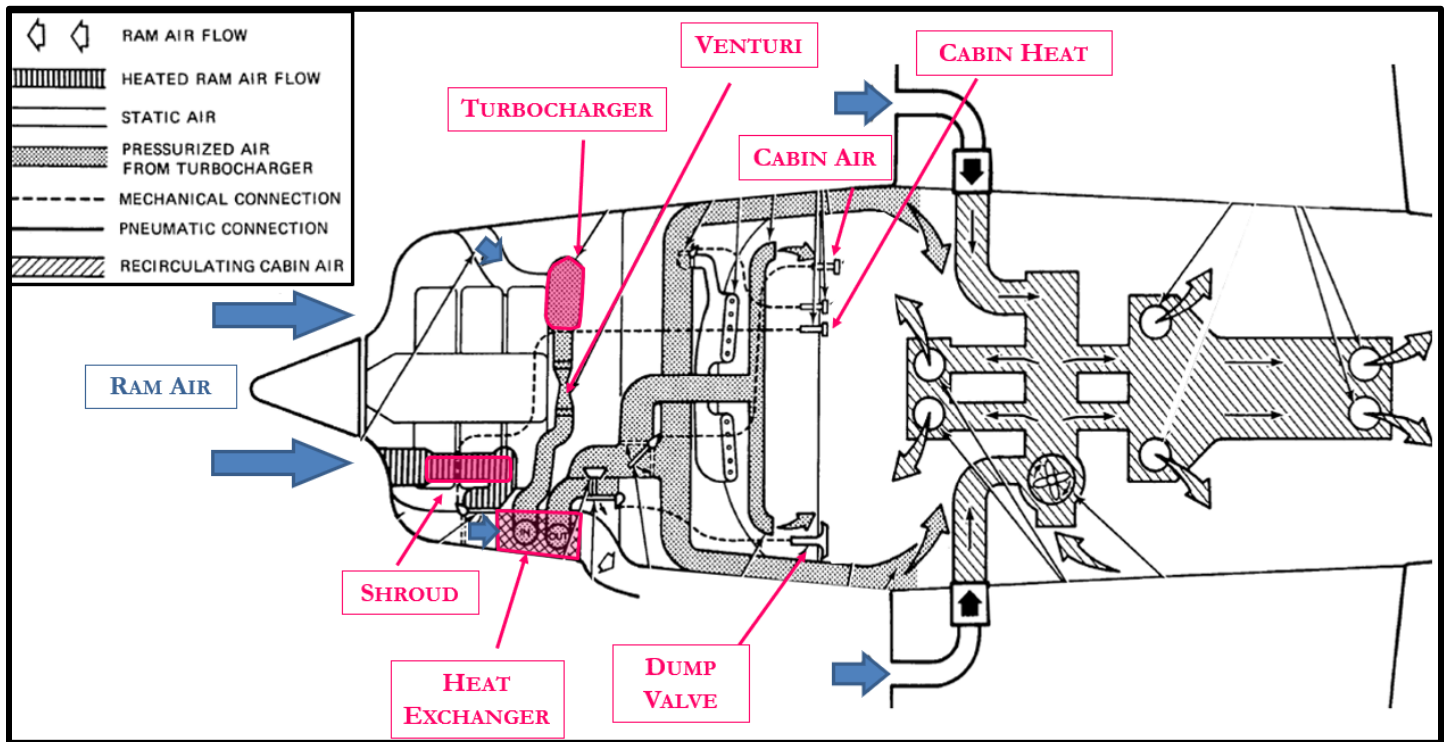


Figure 2: Pressurization System

From the heat exchanger, the bleed air is ducted to a dump valve chamber on the engine side of the firewall. This chamber houses the pressurization system dump valve. In order for pressurized bleed air to enter the cabin from the dump valve chamber, the dump valve control handle on the left side of the instrument panel must be pushed fully in, closing the valve. Otherwise, with the dump valve handle pulled out (dump valve open), bleed air will dump from the chamber to the inside of the engine compartment, flowing overboard through the cowl flaps.

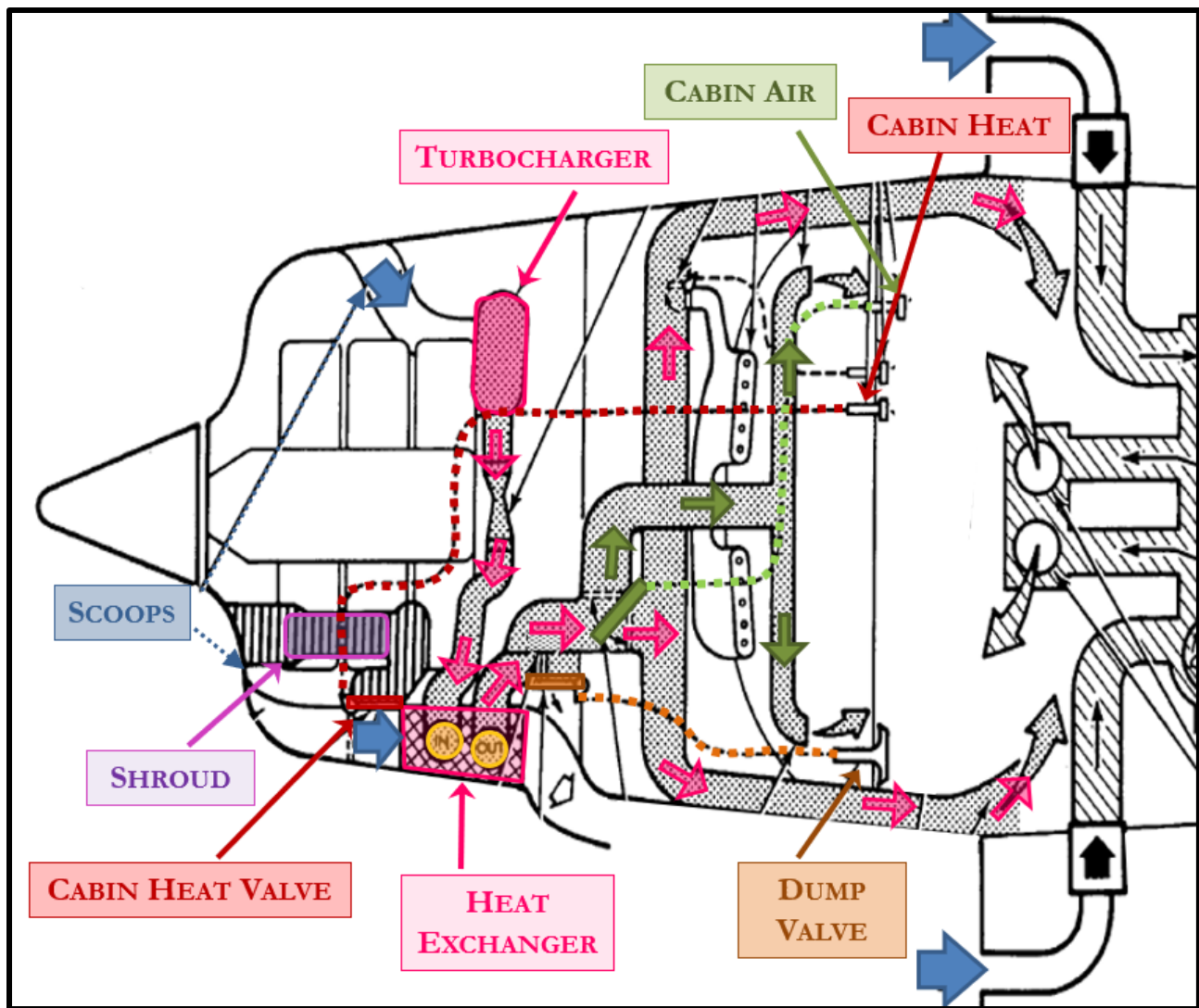


Figure 3: Overhead of Pressurization System (showing airflow)

A cabin air selector valve was located on the cabin side of the dump valve chamber. The air selector -valve allowed a selection of one or a combination of both pairs of fixed outlets depending on the position of the cabin air selector control, located on the right switch and control panel. The forward outlets were located just above the rudder pedals on both sides of the airplane and the other pair of outlets (one per side) were located at floor level on the cabin sidewalls adjacent to the pilot's and front passenger's positions.

CABIN HEATING SYSTEM DESCRIPTION

Air for cabin heating, ventilating and defrosting was supplied by the compressor section of the turbocharger. This heated air (bleed air) was first passed through the heat exchanger where it was either cooled or further heated and then was directed to the cabin through the same ducts and outlets used by the cabin pressurization system. In addition, fresh air for cabin ventilation could enter through the overhead outlet system from airscoops in both wing leading edges anytime the cabin was not pressurized. The cabin heating, ventilating and defrosting system controls were located at the lower edge of the instrument panel. All the controls were the push-pull type and featured a push-button type lock to allow intermediate settings.

The cabin heat control handle was connected mechanically to a valve that admitted ram air to the heat exchanger. The valve allowed ram air at outside air temperature (OAT) or heated ram air from a shroud surrounding the exhaust manifold to pass through the heat exchanger. Since the heat exchanger governs the temperature of bleed air fed to the cabin, the setting of the cabin heat control will determine the cabin air temperature. With the cabin heat control pushed fully in, the air entering the cabin would not be heated. However, pulling the control fully out

resulted in maximum system heating of incoming cabin air. Cabin heat could be selected with the pressurization system operating to pressurize the cabin or with the cabin unpressurized. To obtain heated air flow, the pilot had to ensure the pressurized air dump valve control was pushed fully in, then select the desired cabin air temperature by pulling out the cabin heat control as required.

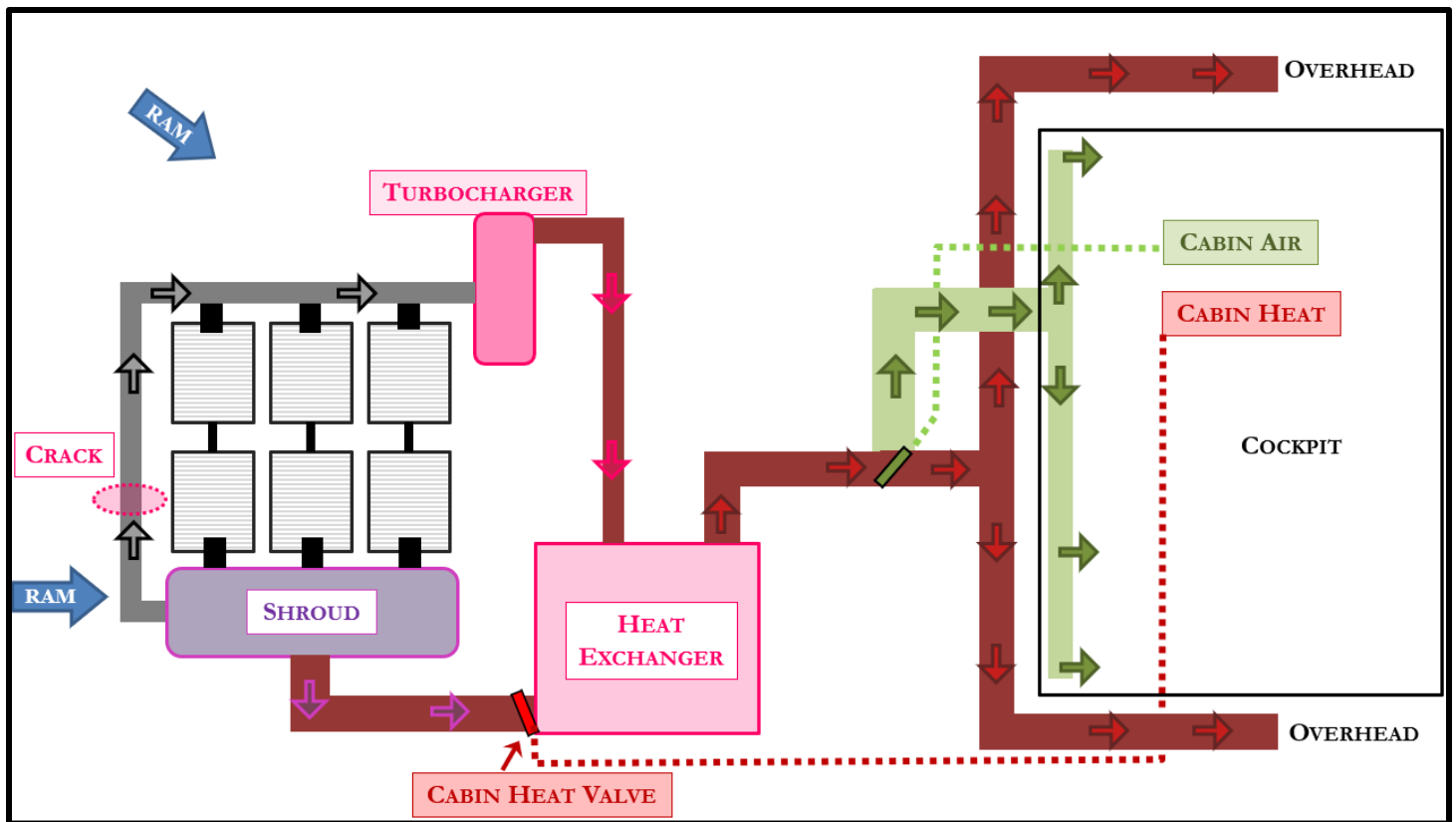


Figure 4: Cabin Heat System

ACCIDENT AIRPLANE

The maintenance records had a pilot-supplied squawk list that said “cabin altitude should always be set 1000 ft above field elevation on dial for takeoff and landing.” The cabin heat knob appeared to have been at least partially pulled out at the accident site, but the exact position could not be definitively determined due to the fragmentation and thermal consumption of the cockpit.

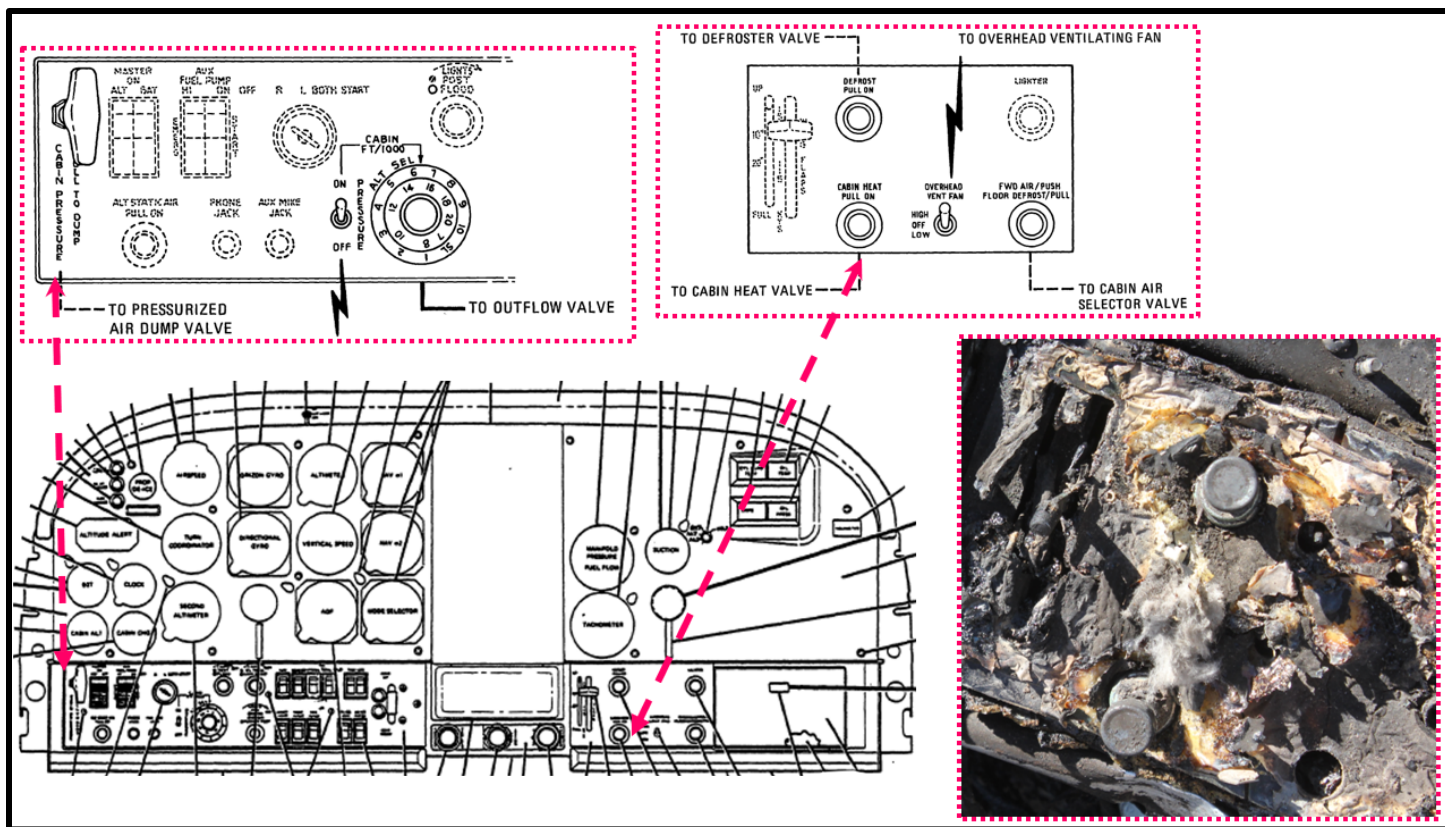


Figure 5: Cockpit

The flange on the exhaust manifold was cracked. For a complete discussion on the crack see the Materials Lab Factual Report in the public docket.

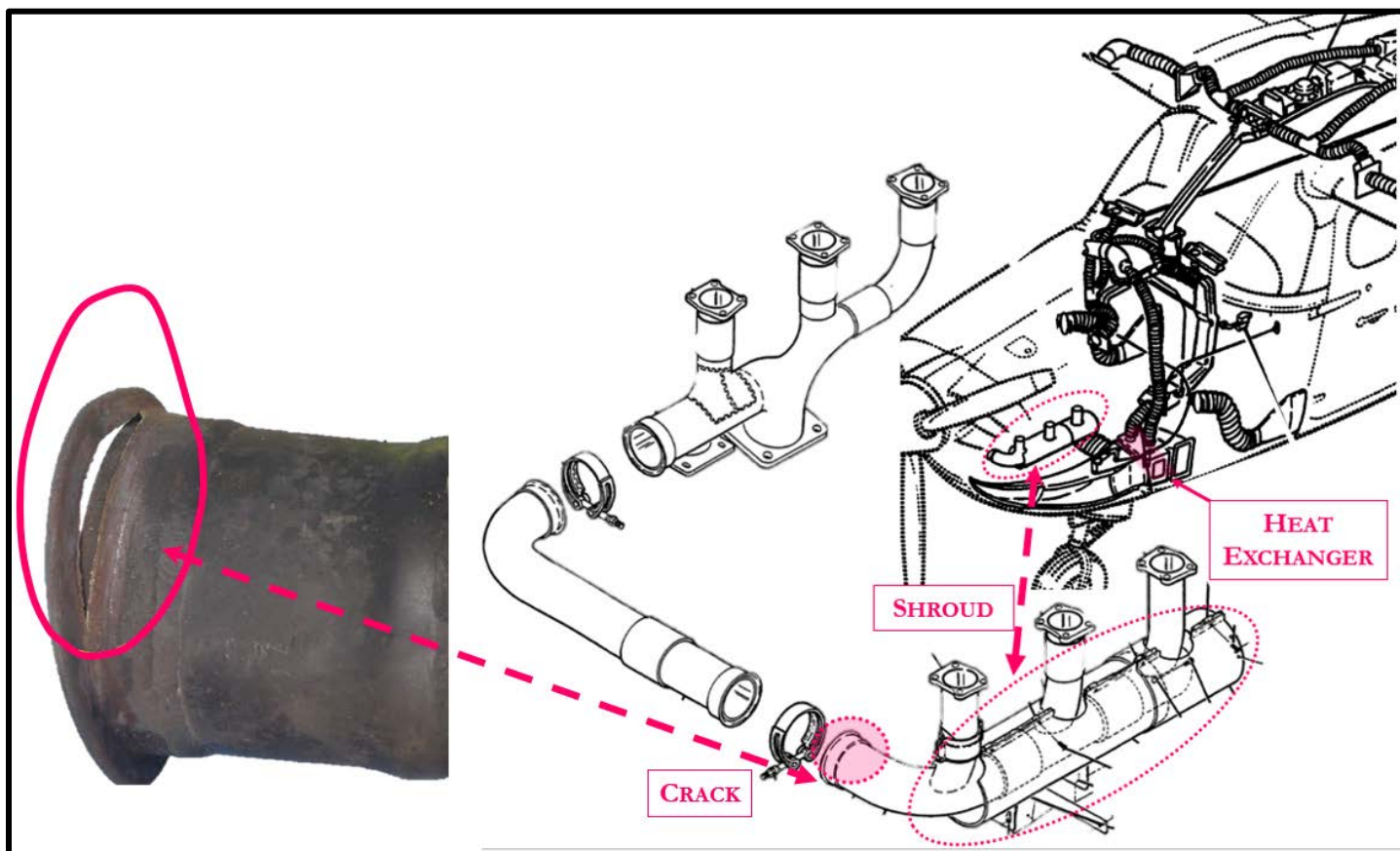


Figure 6: Exhaust System

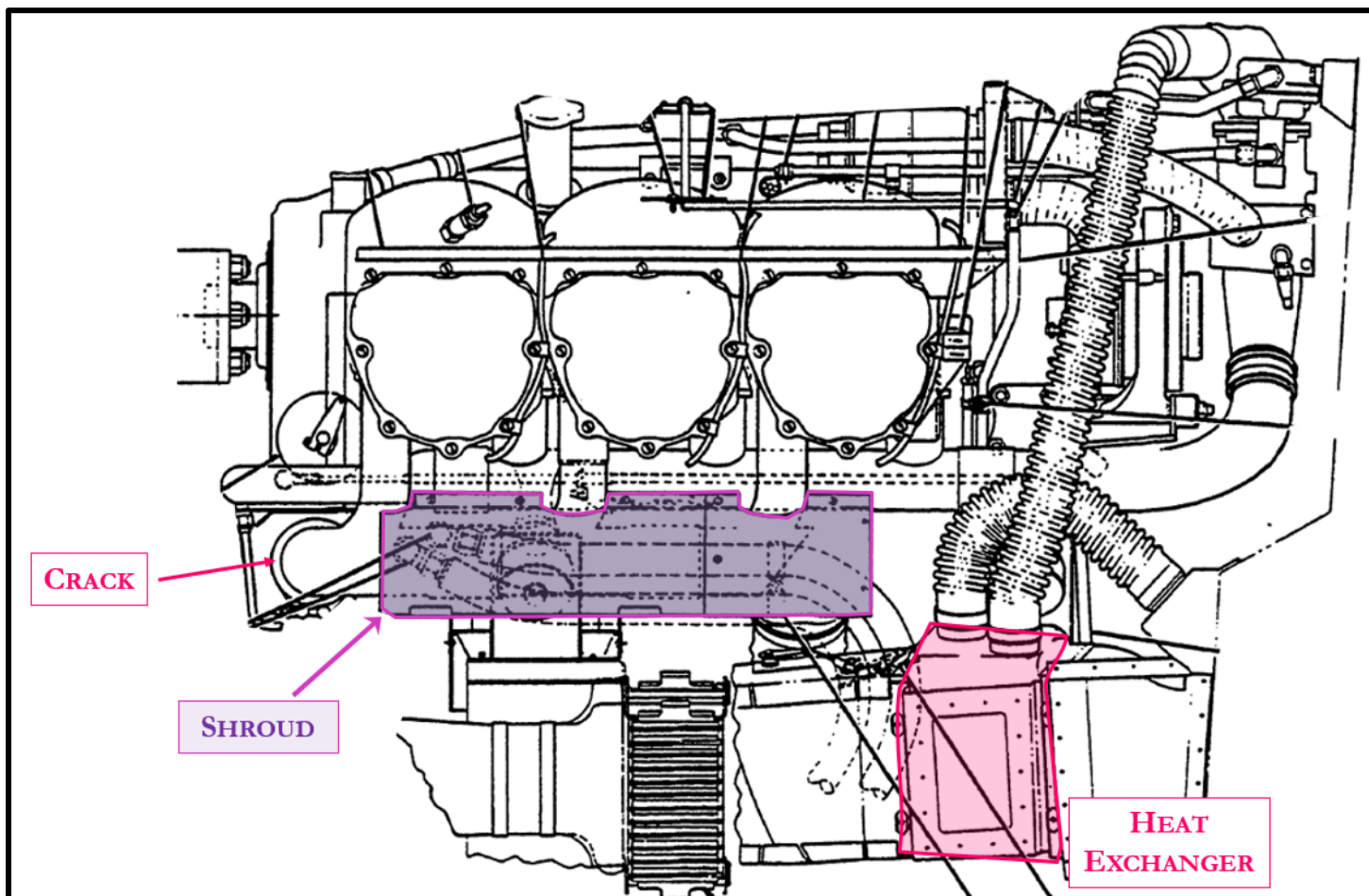


Figure 7: Shroud in Relation to the Heat Exchanger

The main landing gear up lock mechanism is contained outside the pressure vessel in the main gear wheel well. The boots were burned so the condition could not be determined. The nose gear steering boots' condition could also not be determined. If they had cracks and the airplane pressurization system was not on, the exhaust could have entered the cabin.

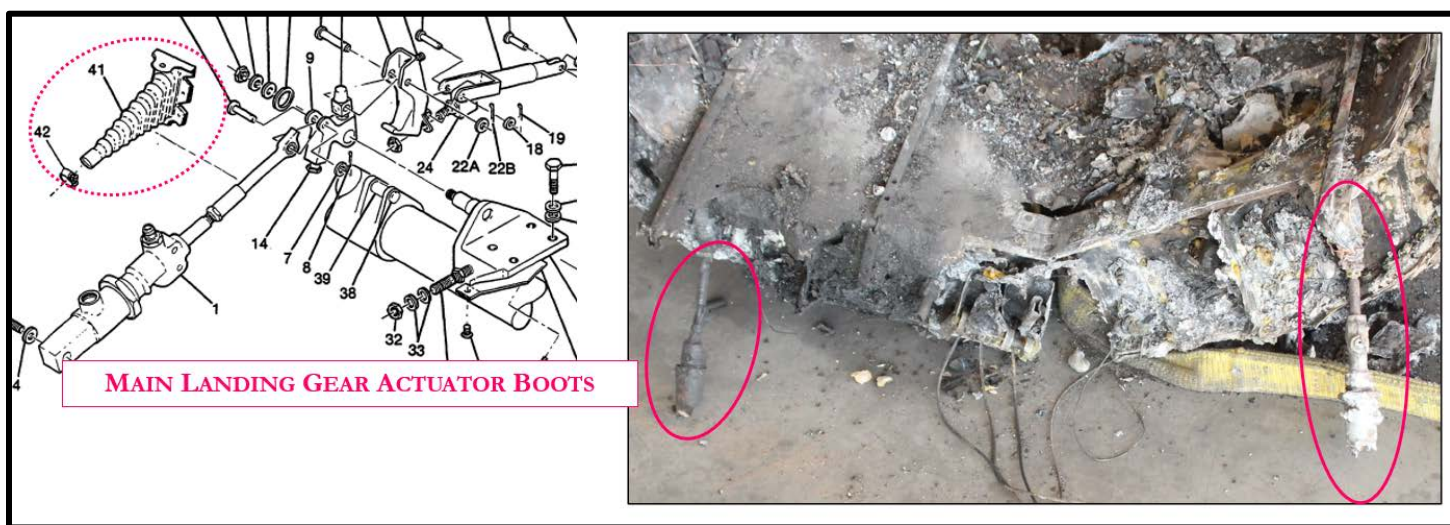


Figure 8: Main Landing Gear Boots

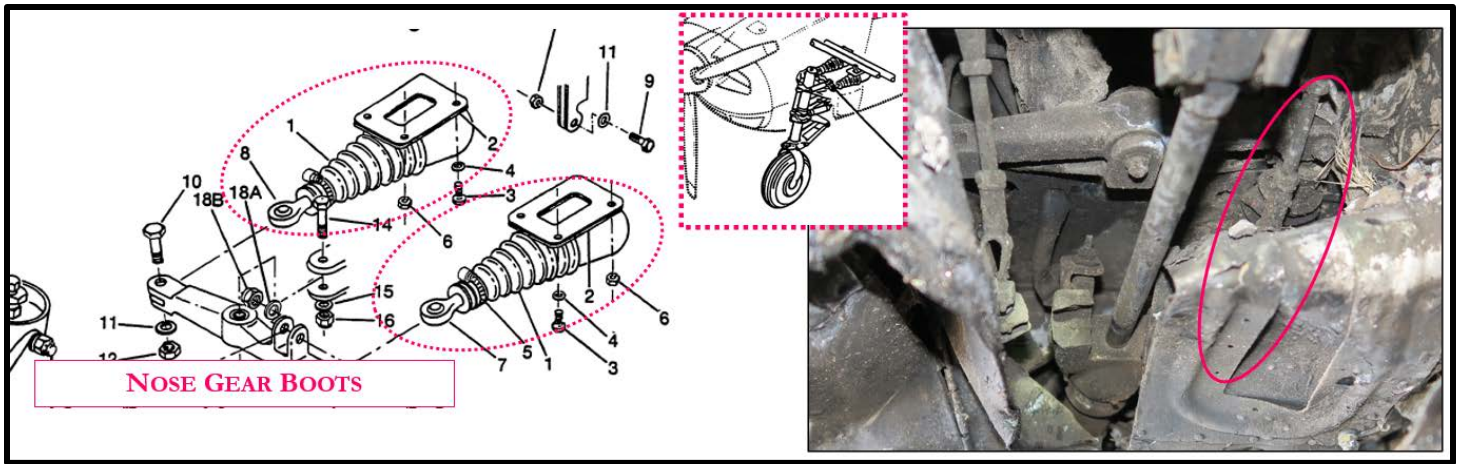


Figure 9: Nose Landing Gear Boots

MAINTENANCE

MAINTENANCE MANUAL (SERVICE MANUAL)

The Cessna Service Manual stated in pertinent part that to install the exhaust system during maintenance, “It is important that the complete exhaust system, including the turbocharger and wastegate, be installed without pre-loading any section of the exhaust stack assembly.” It further stated that “since exhaust systems of this type are subject to burning, cracking, and general deterioration from alternate thermal stresses and vibrations, inspection is important and should be accomplished every 50 hours of operation. Also, a thorough inspection of the engine exhaust system should be made to detect cracks causing leaks which could result in loss of optimum turbocharger efficiency and engine power.” A note stated to “especially check the areas adjacent to welds and slip joints,” looking for “gas deposits in surrounding areas, indicating that exhaust gases are escaping through a crack or a whole or around the slip joints.”

After visual inspection, and air pressure test should be made on the exhaust system as follows: attach the pressure side of industrial vacuum cleaner to the tailpipe opening, using a rubber plug to affect the seal as required. With the vacuum cleaner operating, all joints in the exhaust system and the heat exchanger area may be checked manually by field, or by using a soap and water solution and watching for bubbles. The exhaust manifold in the heat exchanger area must be free of air leaks. In other areas, forming of bubbles is acceptable; however, if bubbles are blown away system is not acceptable... Where surface is not accessible for visual inspection, or for a more positive test, the following procedure is recommended: remove exhaust stack assemblies; use rubber expansion plugs to seal openings; using a manometer or gauge, apply approximately 1.5 psi (3 inches of mercury) air pressure while each stack assembly is submerged in water. Any leaks will appear as bubbles and can readily be detected. It is recommended that any components of the exhaust system found defective be replaced before the next flight. After installation of exhaust system components, recheck by performing the air pressure test to make sure the system is acceptable.

SERVICE LETTERS

SE82-3

Within 10 hours of operation following the initial inspection and every 50 hours time in-service thereafter (except as shown under repair procedures), the exhaust system is to be reinspected according to the attached instructions. MAN-HOURS REQUIRED: Estimated time to inspect the P210 exhaust system, including removal of the cabin heat exchanger shroud, is 1.5 man-hours.

AIRWORTHINESS DIRECTIVE AD81-23-03 R2 (EFFECTIVE ON NOVEMBER 15, 1982)

To ensure the integrity of the engine exhaust system, accomplish the following:

A) Prior to further flight on all airplanes with 25 hours or more time-in-service unless previously accomplished in accordance with AD 81-23-03:

1. Remove the engine cowl side and front panels and visually inspect the entire engine exhaust system for cracks. The cabin heat shroud does not have to be removed for this inspection.
2. Replace any cracked exhaust system components with serviceable parts.

NOTE: Particular attention should be given to the exhaust system components attached to and between the two forward most (Nr. 5 and Nr. 6) cylinders.

B) Within the next 10 hours time-in-service after the effective date of this AD and at each 50 hours time-in-service thereafter except as required by paragraph B)3:

1. Remove the engine cowl side and front panels as well as the cabin heater muff.
2. Visually inspect the entire engine exhaust system for cracks and bulges in the exhaust stacks, manifold, turbocharger and wastegate assemblies in accordance with Cessna SIL SE82-3.
3. Replace any cracked or bulged exhaust system components with serviceable parts in accordance with Cessna SIL SE82-3. If the exhaust system components have been removed and replaced with serviceable parts, or repaired by welding, reinspect within 25 hours time-in-service and replace or repair cracked or bulged components in accordance with Cessna SIL SE82-3. If no defects are found, the 50-hour inspection interval may be reinstated.

...

D) The inspection required by paragraph A)1 of this AD may be accomplished by the holder of at least a private pilot certificate issued under Part 61 of the Federal Aviation Regulations on any airplane owned or operated by that person (provided the airplane is not used in air carrier service). Make the prescribed entry in the aircraft maintenance record appropriate to this inspection.

AIRPLANE'S MAINTENANCE RECORDS

The following maintenance was the most recently completed maintenance listed in the logbooks:

DATE	Tach	Work Performed	MX Time	Exhaust/Heater	Notes
4/30/2018	2194.4	Oil Change; Check Spark Plugs; Check Main Tires	4.25		
5/8/2018	2192.7	Left tire change; panel light check	2.3		
5/13/2018	2195.9	Pilot replaced landing light			
6/27/2018	2203.1	Annual Inspection	40.7	c/w AD81-23-03	06/05-06/27
8/17/2018	2210.8	Troubleshoot aircon system; repaired vacuum system; replace egt probe	13.3		7/24-8/17

Figure 10: Maintenance

The maintenance records showed that AD81-23-03 was complied with a regular intervals:

DATE	Tach
1/28/2013	1874.6
12/24/2015	2069.3
12/28/2016	n/a
5/9/2017	2159.3
6/27/2018	2203.1

DISCREPANCY		ACTION TAKEN		MECH	INSP	TIME
1.	C/w AD 81-23-03 R2 Engine Exhaust	Inspected per AD 81-23-03 R2, by visual inspection, no Redeck noted, R2, 50 in hr				.7

Figure 11: Last AD Compliance Recorded