NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, D.C. 20594

Airworthiness Factual Report

June 4, 2018

A. ACCIDENT WPR17LA104

Location:	Firebaugh, California
Date:	May 15, 2017
Time:	1644 Local Time
Aircraft:	Lancair Evolution, N846PM

B. GROUP

Chairman:	Tom Jacky National Transportation Safety Board Washington, D.C.
Member:	Gail Sober Federal Aviation Administration Oklahoma City, OK
Member:	William Thompson Enviro Systems, Incorporated Seminole, OK

C. SUMMARY

On May 15, 2017, about 1644 Pacific Daylight Time (PDT), an Evolution Aircraft, Lancair Evolution, N846PM, was substantially damaged during a forced landing attempt at Firebaugh Airport (F34), Firebaugh, California. The private pilot and 2 rear seat passengers did not sustain any injuries. A front seat passenger and rear seat passenger received minor injuries. The airplane was owned and operated by a private individual and operated by the pilot under the provisions of Title 14 Code of Federal Regulations Part 91. Visual meteorological conditions prevailed, and an instrument flight rules flight plan was filed for the cross-country flight that departed Livermore Municipal Airport (LVK), Livermore, California at approximately 1400. The personal flight was destined for Marana Regional Airport (AVQ), Marana, Arizona.

During the post-accident examination of the accident airplane, the following components were removed and retained by the National Transportation Safety Board for further examination:

1. Multifunction Display
   Manufacturer: Radiant Power Corporation
   Part Number: A2120

Serial Number: 005111
Manufacture Date: 0914

2. Climate Controller Unit
Manufacturer: Radiant Power Corporation
Part Number: A2245
Serial Number: 005014
Manufacture Date: 1014

3. Enviro Autoscheduling Pressurization System II (eKAPS II) Controller
Manufacturer: Enviro Systems Incorporated
Part Number: 52811-701
Serial Number: 05008
MFG: 0B9E8
Manufacture Date: 08 2015
Mod Information: A, B marked
Software Control Identifier: 003
Software Part Number: 80253-1

4. Enviro eKAPS II Outflow Valve, 3-Inch
Manufacturer: Enviro Systems Incorporated
Part Number: 52812-701
Serial Numbers: 00119
MFG: 0B9E8
Manufacture Date: 08/2015
Mod Information: None Marked

5. Enviro eKAPS II Outflow Valve, 3-Inch
Manufacturer: Enviro Systems Incorporated
Part Number: 52812-701
Serial Numbers: 00120
MFG: 0B9E8
Manufacture Date: 08/2015
Mod Information: None Marked

6. Evolution Aircraft Pressure Bucket
Part Number: 284-0312
Serial Number: Not Serialized

The Pressurization System Controller and the two Outflow Valves were examined at their manufacturer. No faults were found in the testing or operation of the components. The Pressurization System Controller's recorded non-volatile memory (NVM) had no information stored from the accident flight.

The Multifunction Display and Climate Control Unit were examined for non-volatile memory. No non-volatile memory was available on either component, according the component manufacturer.

D. DETAILS OF INVESTIGATION

The airplane was identified as follows:

Make:	Evolution Air, LLC
Model:	Lancair Evolution
Serial Number:	EVO-0065

Due to the circumstances of the accident, the cabin pressurization system was the focus of the airworthiness portion of this investigation.

Following the initial on-scene examination of the airplane, the airplane was moved into a hangar at Madera, California. From October 11-12, 2017 NTSB investigators further examined the accident airplane. During the examination the airplane's Multifunction Display and Pressure Bucket holding the Pressurization Controller, two Outflow Valves, and associated plumbing were removed.

Following the examination at Madera, CA, the Airworthiness Group was formed to further examine the removed pressurization system components.

In February 2018, at the request of the Investigator in Charge, the Climate Control Unit (CCU) was removed from the accident airplane and sent to the group chairman for further examination.

The group met at the Enviro Systems LLC facility in Seminole, Oklahoma on February 12, 2018, to examine the Pressurization Controller and two Outflow Valves, still installed in the Pressure Bucket. Upon arrival of the group, the components were removed from storage, the box opened, and the components visually inspected. All three components were shipped in the airplane's Evolution Aircraft pressure bucket, as removed from the accident airplane.

1.0 Cabin Pressurization System Description

The airplane was equipped with an Enviro Systems, Inc. Autoschedule Pressurization Systems II (eKAPS II) cabin pressurization system. The system consisted of a pressurization controller, two outflow valves, and a climate controller unit. The pilot controls and monitors the system via a flat panel touchscreen, multifunction display. See Figure 1 for a system schematic.

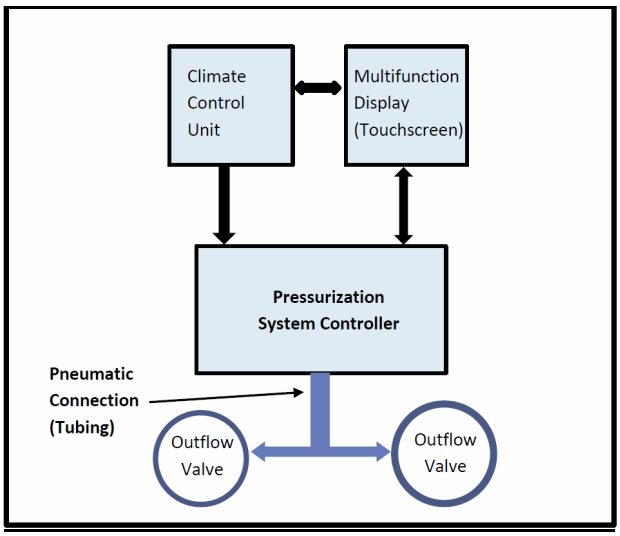

Figure 1 - Simplified schematic of the airplane's cabin pressurization system.

The pressurization controller and two outflow valves are mounted in an Evolution Pressure Bucket with associated static ports and pneumatic plumbing. See Figure 2.

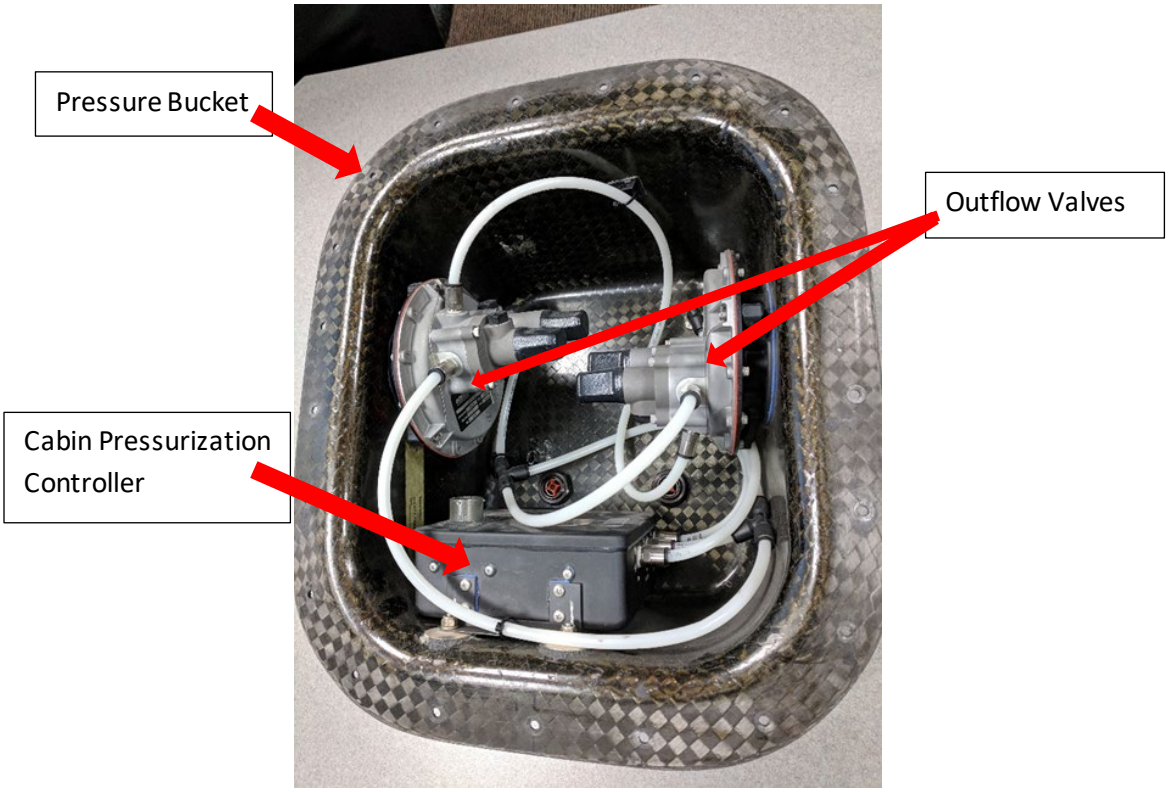

Figure 2 - Cabin Pressure Components installed in Pressure Bucket.

As installed, the system automatically controls cabin pressure and altitude using the system's pneumatic plumbing and electrical wiring to regulate the cabin air exhaust rates. See Figure 3.

Figure 3 – Close up photograph of Outflow Valves and Cabin Pressurization Controller, as Received.

2.0 Multifunction Display Description and Examination

The Radiant Power Multifunction Display is a 7-inch flight deck, flat-panel display that was installed on the far right-hand side of the airplane's instrument panel. The display provides airplane system information, including cabin pressure system information. The pressurization information is presented on the Cabin Pressure Control System (CPCS) pages which are selectable via the display's touchscreen.

The multifunction display was removed for examination to determine whether it stored non-volatile memory that would provide information regarding the accident flight. According to the manufacturer, the unit did not record any flight data or information related to the cabin pressurization system.

No further examination of the multifunction display was accomplished.

3.0 Climate Controller Unit

The climate controller unit (CCU) controls the airplane's cabin temperature and air vents by electrical connections to the pressurization system controller and multifunction display.

The airplane's CCU was removed for examination to determine whether it stored non-volatile memory regarding the cabin pressurization system. According to the manufacturer, the CCU did not record any flight data or information related to the cabin pressurization system.

No further examination of the CCU was accomplished.

4.0 Pressurization System Controller

4.1 Description of Pressurization System Controller

The pressurization system controller is the main component of the airplane's pressurization system. The controller automatically monitors and regulates the airplane's cabin pressure and the difference between the cabin and static pressure values. The controller adjusts cabin pressure by commanding the two outflow valves, via a common pneumatic connection, to open and close as necessary.

The controller is programmed to maintain the airplane's cabin pressure to within a maximum 6.5 psi pressure differential throughout the airplane's operating envelope. To accomplish this, the controller receives static altitude and flight phase information from the airplane's flight management system. The controller is equipped with an internal transducer to measure cabin pressure. After the controller compares the cabin pressure to the outside static pressure, the controller sends pneumatic signals to the outflow valves to control and maintain cabin pressure.

The controller is equipped with several methods for input and output of information. The controller receives and sends information to the airplane via ARINC 429 data busses. The controller has an RS232 port for connection to a computer for software updates and to access data. Finally, the controller has internal, non-volatile memory that records the time of controller being powered, time of operation, and controller-determined faults.

4.2 Pressurization System Controller Examination

4.2.1 Visual Examination and Initial Pressure System Leak Tests

No damage was noted during the visual examination of the Pressurization System Controller; however, it was noted that the controller was installed into the pressure bucket using only two of the four mounts.

The three components, still mounted in the pressure bucket, were placed onto a test bench. An initial, system-level, functional pressure leak test was conducted on each of the pressure bucket's two static ports. The Enviro System's Precision Pressure Controller Monitor (PPCM) was connected sequentially to each static port to conduct the test. No leaks were noted.

For the examination, the controller was connected to an Enviro Systems KAPSII Test Box. A 28 Volts Direct Current (VDC) power supply, ARINC 429 Input/Output Test Interface, and Windows computer via RS232 serial port, were connected to the KAPSII Test Box to facilitate the test. See Figure 4 and 5.

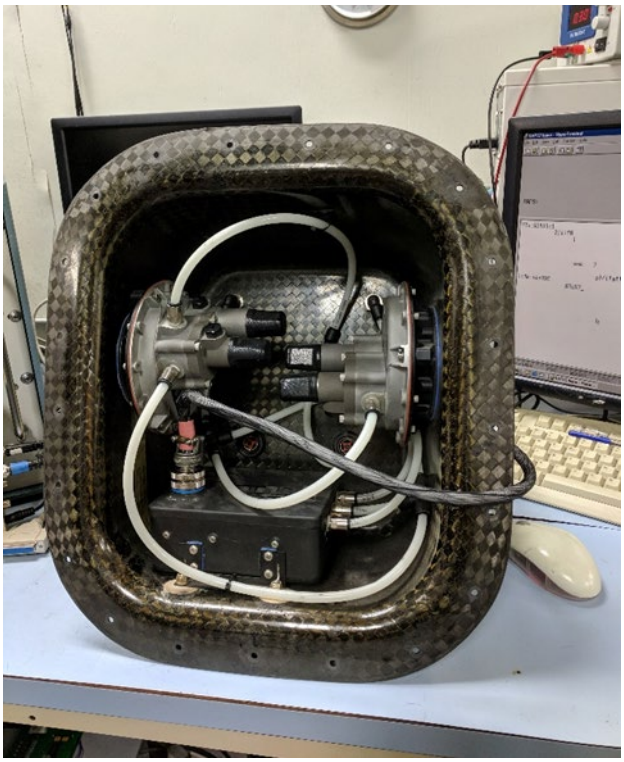

Figure 4 - Cabin pressurization components, as connected to Enviro Systems Test Bench.

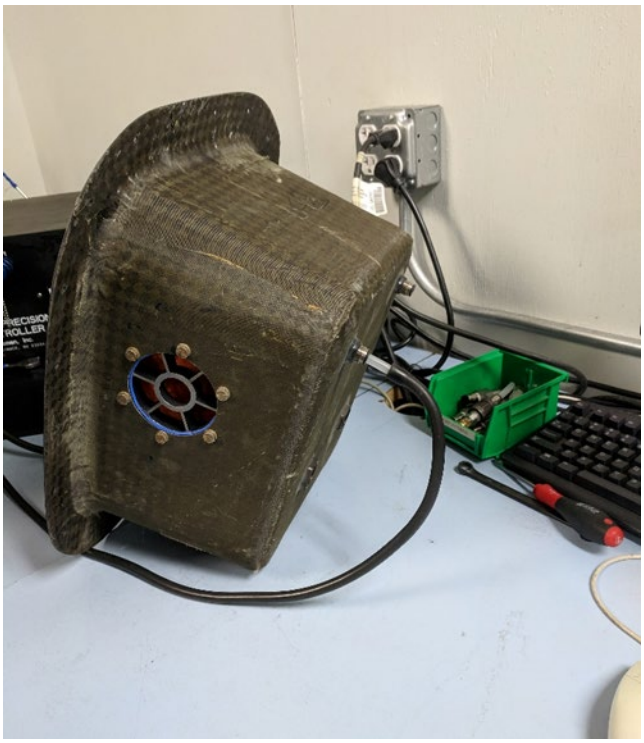

Figure 5 – Rear side of Pressure Bucket, as connected to Enviro Systems Test Bench, in preparation for testing.

4.2.2 Review of Non-Volatile Memory

Power was applied to the controller to access information recorded in memory. The following Pressurization System Controller maintenance information was retrieved:

Total (Power On) Time:	239:24 (hhh:mm)
Total Flight Time:	192:36

After connection to test equipment, a query of the controller's memory determined there were errors present on the controller. There were three errors logged on the system. As determined by the download and conversion of the controller's memory, the following errors were noted:

1. "vacuum leak detected" at 43:03:59 (hh:mm:ss), (4 times)
2. "excessive use of pump detected" at 43:03:59, (4 times)
3. "climb solenoid fault" at 43:05:47, (1 time)

In addition, the following information was noted on the Error Log page:

1. "Log was cleared" at 42:55:32 (hh:mm:ss) (1 time)
2. Elapsed Time: 239:19:43

Enviro Systems indicated that the three errors are triggered normally during the aircraft build process. The errors were triggered during ground testing when air inflow is not present, and the controller is unable to control the cabin altitude.

Based on the controller's operating time when the errors were triggered and, compared to the controller's Total Power on Time and Elapsed Time, Enviro Systems indicated the errors most likely occurred during the original functional testing during the aircraft build process.

There were no other errors recorded.

4.2.3 Acceptance Test Protocol

The Acceptance Test Procedure for the eKAPS II Controller (ATP52811-701, Pressurization System Controller, dated January 13, 2014) was conducted on the controller. The test configuration used for the memory query was used for the ATP test.

The controller passed the ATP and met all original functional requirements. All data communication from the controller was verified as part of the functional test. The Acceptance Test Data Sheets were included in Appendix B of the Evaluation Test Report, included as the attachment to these field notes.

5.0 Outflow Valves (2), 3-Inch

5.1 Description of Outflow Valves

The airplane was equipped with two, identical pneumatic/mechanical outflow valves. The outflow valves regulate the pressurized air (~6.5 pounds per square inch) in the airplane cabin. The operation of the outflow valves is directed from pneumatic signals from the pressurization controller. When the outflow valves are opened, pressurized cabin air escapes the airplane to keep the 6.5 psi differential.

Both outflow valves feature an independent Maximum Differential Pressure Limiter (a.k.a. Delta P Limiter) and a Maximum Altitude Limiter (a.k.a. MAL).

5.2 Examination of Outflow Valves

5.2.1 Visual Examination

The two outflow valves were removed from their pressure bucket mounting structure for further testing and visual examination. The valves were the same model number and were consecutive serial numbers. No damage was noted to either valve during the visual examination.

5.2.2 Acceptance Test Protocol

The Acceptance Test Procedure for the eKAPS II Outflow Valve (ATP52812-701, dated July 18, 2014) was conducted on each valve. For the tests the valves were connected to the Enviro Systems PPCM and later, attached to a vibration fixture.

The results of the ATP test on each Outflow Valve were as follows:

Serial Number 00119

Outflow Valve serial number 00119 passed ATP and met all original functional requirements. As part of the ATP, the valve air filters were removed, inspected, and found to be free of any contamination.

The ATP set point of the maximum differential pressure limiter 6.42 PSID (488.4 knots) was within the specified tolerance of 6.5±0.1 PSID. The maximum altitude limiter was measured at 14,303 feet (ft), within the specified tolerance of 14,300±300 ft, allowed by the ATP.

Serial Number 00120

Outflow Valve serial number 00120 passed ATP and met all original functional requirements. As part of the ATP, the valve air filters were removed, inspected, and found to be free of any contamination.

The ATP set point of the maximum differential pressure limiter 6.42 PSID (488.7 knots) was within the specified tolerance of 6.5±0.1 PSID. The maximum altitude limiter was measured at 14,224 ft, within the specified tolerance of 14,300±300 ft, allowed by the ATP.

For both Outflow Valves, the Acceptance Test Data Sheets were included in Appendix B of the Enviro Systems Evaluation Test Report. The report was included as the attachment to this report.

After completion of the tests, the components were repackaged in the shipping box and returned to secure storage. The Enviro Systems sent the components to the NTSB group chair on April 23, 2018.

Enviro Systems submitted a Test report that was included as an attachment to this report, dated March 19, 2018.

Tom Jacky

Aerospace Engineer

Attachment – Evaluation Test Report, Cabin Pressurization Control System