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All persons listed were interviewed by NTSB personnel:

The following is a summary of conversations:

[REDACTED]

The pilot/owner stated that he was a mechanic and performed the maintenance on the airplane, which he built. He recently completed the 40-hour flight test period for the airplane, which had accumulated 43 hours of flight time. He decided to perform a condition inspection, which he and another mechanic completed the day before the accident flight. In June 2023 he noted that he was not getting the speed he needed out of the airplane, and during takeoff he would be flying at what felt like a too-nose-high attitude. During the inspection, he discovered exhaust valve leaks causing low compression (in the 60's psi range) on all cylinders. He said a borescope exam revealed lead deposits on the exhaust vales, which was identified with a testing device and through audible sound of air escaping through the exhaust. He spoke with a representative of the engine manufacturer, Ray Lawrence of ULPower, who recommended he use 93- or higher-octane unleaded auto fuel rather than 100LL, to help clean the existing engine deposits and prevent future deposits, and that he run the engine for five or six hours to burn off the lead deposits, then recheck cylinder compressions. 93-octane fuel was not available in the Tucson areas, so the pilot purchased 50 gallons of 91-octane unleaded gasoline with no/minimal additives at a local Shell service station, and then mixed that fuel with 100LL aviation fuel at a ratio of 85% 91-octane unleaded gas, and 15% 100LL avgas, which he calculated would result in a fuel blend meeting the octane requirement. He also added Decalin RunUp, a commonly used fuel additive that helps prevent and remove lead deposits. The fuel was purchased a week or two before the accident flight.

When he built the airplane, he configured it with two electronic control units (ECUs), and two fuel pumps. Recently the No. 2 fuel pump (inboard) was leaking so he ordered a new one and installed it. He also replaced fuel hoses per a service bulletin and installed two new fuel filters, which he ordered from Wicks. After completing the work, the airplane was taxied for a total of 1 to 1.5 hours. He was getting 35-55 psi for fuel pressure and in the 40s during high-power engine runs. There were no leaks.

The accident flight was the first one conducted with the new, blended fuel mixture. The day of the accident, he taxied for a while to run the new fuel mix through the engine and ensure everything was working properly, then taxied to runway 10. The fuel tanks were about 3/4 full. All the runup checks went well and he performed a normal takeoff. After departing, the fuel pressure light began blinking. He stated the engine experienced a partial, then complete loss of power. He switched to the No. 2 ECU and the No. 2 fuel pump, which are controlled using independent switches for each ECU and each fuel pump located on the right-side panel in the airplane. The engine restarted but would not perform at full power. Any attempt to advance the throttle caused the engine to cough and lose power, so he returned it to idle. The engine quit again, and he was unable to get it to restart. He determined he could not return to the airport, aimed for a nearby road to land on, and touched down about 50 feet from the road. The airplane landed hard, the gear collapsed; the right-wing leading-edge spar and both wing struts were substantially damaged. The ELT activated and he was uninjured. After exiting the airplane, he discovered the gascolator was damaged in the hard landing and was actively leaking fuel, so he shut off the fuel system at the cut-off valve in the cabin.

When asked about design resources he used when installing the engine and fuel system, he referred to the ULPower installation manual, AC 43.13, and consultations with other IAs. He said the fuel system design involved inserting a 1.75-gallon header tank to accommodate the ULPower engine's required fuel, and a fuel return line. He also chose to use hard aluminum fuel lines instead of plastic, to avoid the need for annual replacement. After the accident, during the engine tests conducted by NTSB and ULPower, he learned that the installed fuel lines should be larger in diameter for that engine installation.

The pilot/owner is going to repair the airplane and plans to implement several changes recommended by ULPower representative Ray Lawrence, which were identified as areas for improvement to help prevent recurrence:

- Remove the gascolator from the system
- Install an electric fuel boost pump at the header tank
- Increase the fuel line size from the header tank forward, and for the return line
- Relocate the metallic fuel pumps and filters to the right-hand side of the firewall, further away from the exhaust system on the left side
- Potentially build an air-cooled enclosure for the fuel pumps
- Minimize the number and severity of bends in the fuel lines

RAY LAWRENCE

Ray Lawrence, a representative of engine manufacturer ULPower, travelled and participated in the examination of the airplane, fuel system, and engine. He stated that the fuel system consisted of a header tank gravity fed from the wings, followed by fuel supply and return lines between the header tank and the engine. He noted the supply line was 3/8 inch diameter, but because the distance from

the header tank to the engine was greater than 10 feet, these lines would need to be 1/2 inch diameter to avoid excessive suction workload on the fuel pumps.

He also observed that the fuel return line was 1/4 inch diameter, whereas ULPower specifies a minimum diameter of 5/16 inch. He noted that a 5/16-inch line provides flow capacity more than double that of a 1/4-inch line. For this specific airplane's application and length of the line, he stated he would recommend the use of 3/8-inch line to avoid restricting fuel return flow. He also noted that the installed fuel lines appeared to match those sizes typically recommended for carbureted Rotax engine installations, which have lower fuel flow/volume requirements than the installed ULPower engine.

He stated he observed an elevated fuel pressure of 48 psi, with the fuel pump on and engine off, where one would normally expect ~43 psi. He believed this was caused by the undersized fuel return line. This configuration would create a higher-than-normal workload for the fuel pumps.

He also noted that the onboard fuel, which the pilot had stated was a mix of auto fuel and 100LL at the time of the accident flight, may have been a contributing factor. He noted that automotive fuel companies provide both winter and summer fuel blends, and that summer-blend fuel contains additives intended to reduce the possibility of fuel vapor lock that accompanies higher temperatures. This incident occurred during a "transitional" time frame, when winter-blend fuel may still be in gas stations tanks and not yet consumed, and while ambient/operating temperatures are increasing.

Lawrence also mentioned that the pilot told him that on the day of the accident, he had taxied to one end of the runway, then back to the opposite runway. That resulted in longer than typical engine ground-run time, coupled with low cooling airflow. To some extent, this likely increased the temperature of metal fuel system components within the engine cowling, which in turn could increase the possibility of fuel vaporization.

He further commented that following the post-accident engine evaluation runs, which included full-power engine ground runs alternating between the two fuel pumps and both ECUs, he noticed that all engine components were very hot and heat soaked, and that even after approximately 20 minutes that it took to move the airplane back inside the hangar after the engine runs, the parts were still hot and it took a considerable amount of time for the warm fuel pumps to reprime and start pumping fuel. When the pumps eventually did get primed, the fuel was so aerated it appeared white/cloudy for 2 or 3 seconds as it exited the hose attached to the fuel return outlet, then cleared to normal, followed by normal pressure returning to the system.

Based on the fact that the engine started and ran normally during the tests, and the items noted above, Lawrence stated he believes these combined observations point significantly to fuel and/or vent problems.

Lawrence also provided copies of the ULPower installation and operations manuals for the installed engine, which are available on the ULPower website. He explained that the engine installation manual specifies the minimum inside diameter sizes for the fuel feed and return lines as well as the

required fuel pressure and volume that must be maintained. He also explained that the installation manual contains guidance that while 100LL fuel can be used, the ULPower engines prefer lead-free fuel such as Mogas or Avgas UL91. It also contains warnings about the use of fuels prone to vapor formation, and that the installation, operation and fuel choices must take vaporization risks into account. The ULPower engine operations manual also contains appropriate fuel specifications.

RANDY SCHLITTER

Randy Schlitter, president of RANS Designs and designer of the S-7S airplane and kit, was contacted by telephone. He stated that RANS does not provide an approved installation method or a design specification for the ULPower engine, and that the only standard manufacturer-specified engine for the S-7S is the Rotax 912ULS. Therefore, the fuel delivery system specification provided for the S-7S is only valid for installation of the Rotax 912ULS engine. He noted that, given the ULPower fuel-injected engine's higher fuel flow and pressure requirements, the standard S-7S kit's fuel delivery plumbing would likely not suffice. He confirmed that all the fuel system feed tubes provided in the S-7S kit are 1/4-inch inside diameter. He stated that because each engine brand/model/type has different and unique demands and requirements, the aircraft kit builder must refer to the engine manufacturer's design and performance requirements to determine a suitable fuel system design.