



MEMORANDUM FOR RECORD

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Office of Aviation Safety – Western Pacific Region

NTSB Accident Number: WPR21LA299
Aircraft Registration & Make/Model: N3629F; Schweizer G-164B
Accident Location: Tracy, California
Accident Date: July 30, 2021

Note: The following information was captured from the engine manufacturer's examination report of a model TPE331-2-201A turboprop engine serial number P-90095C, by the Investigator –In-Charge (IIC), Stephen Stein.

According to the analysis section of the report,

“Engine rotation at the time of impact was evidenced by:

- The propeller shaft displayed rotational scoring through 360 degrees immediately aft of the propeller shaft nut with corresponding rotational score marks on the sun gear forward inner bore.*
- The propeller shaft lock nut displayed rotational scoring, associated with rotational contact of the planet gears.*
- The propeller shaft displayed rotational scoring through approximately 90 degrees on the aft taper, with corresponding rotational score marks on the sun gear aft inner bore.*
- The aft bull-gear bearing liner displayed rotational scoring with corresponding rotational score marks on the forward face of the second Direct Drive Fuel Control (DDFC), forward gear, teeth tips*
- The sun gear displayed rotational scoring on the forward, inner bore leading edge with corresponding score marks on the propeller shaft immediately behind the nut.*
- The sun gear displayed rotational scoring on the aft face of the gear teeth with corresponding rotational scoring to the forward face of the propeller shaft aft roller bearing outer race.*
- The bull/sun gear nut displayed a rotational score mark with corresponding scoring to the outer diameter of the gear shoulder just inboard of the gear teeth on the 4th DDFC idler gear.*
- The bull/sun gear nut displayed rotational scoring with corresponding rotational scoring to the torque sensor housing.*

- Rotational scoring was noted on the forward face of the aft prop shaft roller bearing outer race with corresponding rotational scoring on the face of all the aft gear teeth of the sun gear.
- The torque sensor housing displayed rotational scoring on the forward housing surface with corresponding rotational damage to the sun gear nut.
- There were rotational score marks on the aft surface of the torque sensor indicating contact with the bull/sun gear aft bearing liner.
- Rotational scoring was noted on the gear teeth of the aft gear of the second DDFC.
- There was rotational scoring to the outer diameter of the gear shoulder just inboard of the gear teeth on the 4th DDFC idler gear with corresponding rotational scoring to the bull/sun gear nut.
- The first-stage compressor impeller shroud displayed a shroud rub between 12 to 6 o'clock (ALF) at the exducer area with corresponding rotational scoring on the impeller shroud line edge
- The first-stage compressor impeller vanes displayed rotational scoring on the shroud line edge with corresponding rotational scoring on the first-stage compressor impeller shroud.
- The first-stage compressor impeller had the leading edge of all vanes damaged (rough / pitted) due to foreign object damage.
- The first-stage compressor impeller displayed rotational scoring through 360 degrees on the forward hub with corresponding scoring to the air inlet housing seal area.
- The first-stage compressor impeller displayed rotational scoring through approximately 360 degrees on the aft hub with corresponding scoring on the inner diameter of the crossover duct housing seal area.
- The shroud line edge of all second-stage compressor impeller vanes displayed rotational scoring with corresponding rotational scoring to the second-stage impeller shroud at the inducer, exducer, and "knee" areas of the shroud.
- The first-stage turbine blade tip shroud displayed rotational scoring on 2 segments with corresponding rotational scoring to the shroud line edges of all first-stage turbine blades.
- The first-stage turbine rotor displayed rotational scoring on all blade tips with corresponding rotational scoring on the first-stage turbine blade tip shroud.
- Rotational scoring was noted on all the aft blade platforms associated with the first-stage turbine rotor.
- The second-stage turbine stator displayed rotational score marks on the forward face of the inner vane support with corresponding score marks on the aft face of the first stage turbine wheel blade platforms.
- The second-stage turbine stator displayed rotational scoring through 90 degrees of the shroud surface with corresponding scoring to the shroud line edge of all second stage turbine blades.
- The second-stage turbine rotor displayed rotational scoring on the shroud line edge of all blade tips with corresponding rotational scoring on the second-stage turbine blade tip shroud.
- The second-stage turbine rotor displayed rotational scoring on the aft blade platforms with corresponding scoring to the forward inner vane support for the third-stage stator.
- The third-stage turbine stator displayed rotational score marks on the forward inner vane support with corresponding rotational scoring to the aft blade platforms of the second-stage turbine wheel."

The report also discussed the factors that indicated that the engine was operating at the time of impact. According to the report,

“Operation at the time of impact was evidenced by:

- There were compressor-shroud metal spray deposits on the suction side of the first-stage turbine stator vanes.*
- There were compressor-shroud metal spray deposits on the interior wall of the inner transition liner of the first-stage turbine stator.*
- There were compressor-shroud metal spray deposits on the leading edge of the secondstage turbine stator vanes.*
- There were compressor-shroud metal spray deposits on the second-stage turbine rotor shroud.*
- There were compressor-shroud metal spray deposits on the suction side of the second-stage turbine stator vanes.*
- There were compressor-shroud metal spray deposits on the suction side of the second-stage turbine rotor blades.*
- There were compressor-shroud metal spray deposits on the leading edge of the secondstage turbine rotor blades.*
- There were compressor-shroud metal spray deposits on the suction side of the third-stage turbine stator vanes.*
- There were compressor-shroud metal spray deposits on the outer vane support of the thirdstage turbine stator vanes.*
- There were compressor-shroud metal spray deposits on the third-stage turbine blade tip shroud.*
- The third-stage turbine rotor had compressor-shroud metal spray deposits on the suction side of the blades.*
- The third-stage turbine rotor had compressor-shroud metal spray deposits on the leading edge of the blades.*
- There were compressor-shroud metal spray deposits on the flow surfaces of the turbine bearing support housing.”*

The report included the following observations from the fuel control unit test,

“The unit was returned with customer fittings, power lever and speed lever linkages, pressurizing valve assembly, and the Tt2 sensor still installed. The Tt2 sensor and customer hardware were removed and a visual as-received inspection was performed. Minor damage was observed on the housing near the Pt2 bellows and one of the attachment screws was missing from the main cover. The power lever, speed setting lever, and drive spline were all free to rotate normally.

A slave inlet filter and transfer tube were installed, and the unit was tested per the applicable TSP. The following results were obtained:

- There were three points on the Standard Day Accel schedule out of limits by up to 4.7%*
- There were four points high out of limits on the 15k foot Accel schedule by up to 2.5%.*
- The 30k foot Accel schedule was high out of limits by up to 8%.*
- There was one test point low by less than 1% on the Hot Day Accel schedule*

- *There was one test point high by 4% on the Cold Day Accel schedule.*
 - *Two points on the Decel schedule were low by up to 2%.*
 - *The Underspeed Governor 65% speed schedule was within limits.*
 - *The Underspeed Governor 97% speed schedule had lean fuel flow of 161 pph (Limits: 165 to 175 pph).*
 - *The Overspeed Governor schedule had rich fuel flow at 103.5% speed and lean fuel flow at 105.8% speed.*
 - *At 103.5% speed the fuel flow was 262 pph (Limits: 190 to 210 pph).*
 - *At 105.8% speed the fuel flow was 102 pph (Limits: 104 to 114 pph).*
 - *The standard day Max Power setting on the power lever schedule was within limits.*
 - *The Tt2 Correction test points were high out of limits by up to 1.6%.*
 - *The Pt2 Correction test points were also high out of limits at maximum power lever.*
- NOTE: The Tt2 Correction and Pt2 Correction schedules were consistent with the out of limits fuel flow of the standard day Flight Idle setting.*
- *The 30k foot test point was high by 27% and the 15k foot test point was high by 7%.*
 - *The Flight Idle setting was low out of limits at 138 pph (Limits: 178 to 188 pph). This is considered a normal customer adjustment. The Tt2 sensor bellows length was measured using tool WT-51467 to determine sensor calibration. The sensor measured 1.024 inches at room temperature, which is within calibration requirements of 1.023 +/- .002 at 75 deg F. While several tests were out of specification, none were considered to have contributed to the accident."*

The excerpt below includes observations from the propeller governor test.

"A visual inspection of the unit was conducted. No signs of damage were observed to the unit that would have prevented a functional test.

All test points were found within limits except for the following:

- *"Maximum RPM" was out of limits high at 3939 rpm (Limits: 3574 +/- 10 rpm)*
 - *"Minimum RPM" was out of limits high at 3607 rpm (Limits: 2815 +/-10 rpm)*
 - *"Arm Travel" Max to Min was out of limits low at 24 degrees (Limits: 60 +/- 5 degrees)*
- 17. The shift in the test data were the results of typical adjustments made to the propeller governor in the field. Following the test, the unit was disassembled. There were no anomalies with any of the hardware. In summary, the unit had evidence of being adjusted in the field resulting in the out of tolerance condition during testing. However, even with those adjustments all indications from testing suggest that the unit was functioning properly."*

The observations below were captured from the fuel solenoid shutoff valve with manual override examination.

"The purpose of the fuel solenoid shutoff valve is to introduce fuel to the engine in response to speed switch actuation during engine starting, and to shutoff fuel when the aircraft stop switch is actuated. The solenoid valve is latched open during normal engine operation. During engine shutdown an electrical signal from the shutdown switch in the cockpit closes the fuel solenoid shutoff valve. The fuel shutoff valve may also be closed from the cockpit by the mechanical fuel shutoff and feather lever. In the event electrical power to the shutoff valve is interrupted, engine

operation will not be affected. The Belleville spring washer will hold the shutoff valve in the open position. When the fuel solenoid valve is open, fuel passes through the ball valve and out to the atomizers. The override lever and shaft at the upper end of the solenoid valve is connected to the manual shutdown and feather lever in the cockpit. In the "auto" position the flat underside of the shaft permits movement of the actuator shaft (electrically) without interference.

With the valve latched in the open position by the Belleville spring washer, the override actuating sleeve that surrounds the upper end of the actuator is positioned close to the flat of the override shaft. Rotating the override lever will force the actuating sleeve downward. The increased force from the override spring will overcome resistance of the Belleville spring washer, forcing the valve to close. The valve will be held in the closed position by the Belleville spring washer and the override spring as long as the lever is in the "manual closed" position. In the "manual closed" position a cam on the override shaft positions the No. 1 switch actuating arm to open the switch, preventing the open coil from being energized. The fuel solenoid valve can be opened and closed electrically, and can be closed, but NOT opened manually. A scribe mark on the end of the override shaft must be positioned to point to the top of the valve, to assure that the valve is in the automatic position. During the engine exam, a visual examination of the fuel solenoid valve with manual override determined the manual override shaft to be in the "open" position; the scribe mark on the end of the override shaft was positioned to point to the top of the valve. To determine the actual position of the ball valve, low pressure air was applied to the fuel inlet port of the valve. Air was not able to pass through the valve indicating it was in the closed position.

The closed position of the ball valve would prevent fuel flow to the fuel nozzles. But the prior findings of metal spray throughout the turbine section indicate that there was a flame (fuel being delivered to the engine) in the engine at the time of impact. And since the Belleville washer will hold the ball valve in position through an impact, one of three things must have occurred.

Scenario 1: The pilot operated the electrical engine/fuel shutoff switch located in the cockpit after the aircraft impacted.

Scenario 2: There was an electrical short that energized the closing coil of the solenoid valve at impact.

Scenario 3: The impact caused the manual shutoff actuating arm to move to the closed position and then the airframe "relaxed" pulling the manual shutoff actuating arm back to the "auto" position, as found.

According to the pilot's statement, after the aircraft came to rest, he took no action to shut down or turn off the engine. As such, Scenario 1 is not likely. Honeywell has no record of a fuel solenoid valve being closed in flight and then having been forced open by the impact in an accident. In addition, two actions would need to occur (pulling of the arm to close the valve and then relaxing of the arm to return to the "auto" position) during the accident sequence. Given the accident impact scenario and the airframe remaining relatively intact, this is not a likely sequence of events. As such, Scenario 3 is not likely.

Given the damage to the breaker panel in the aircraft, it is more likely that Scenario 2 occurred thereby closing the solenoid valve at impact with terrain. As this would have occurred at impact, this would not have had an effect during flight.”

Finally, the report include the following observations from the fuel pump test.

“The fuel pump test took place at the Honeywell Engine’s division in Phoenix, Arizona, on June 14, 2022. The pump was tested per the Honeywell Test Instructions TI-869151-1, revision AG. All the tests were successfully passed with the exception of one test point. The unit was slightly below the required minimum flow rate when running Paragraph 3.6, data point 11. Although the pump output flow rate tested slightly below the requirement, this would not have had an effect on normal operation of the engine as this datapoint is well below the operating speed of the engine (approximately 11% engine speed). The output volume of the pump was still well in excess of the required flow rates for continued, normal operation. No anomalies were noted with the fuel pump that would have prevented normal operation.”