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N656TE Crash Investigation Report

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Abstract:

Lochie Ferrier's family gave Israel Briggs and Marc J. Zeitlin permission to examine the wreckage of COZY MKIV N656TE at a hangar at the Half Moon Bay Airport (KHAF) on March 10th and 11th, 2025. Israel Briggs conducted an additional site visit on April 6th, 2025 to collect several ignition components for off-site inspection and analysis.

These examinations were separate from and in addition to any previous examination by the NTSB, FAA or any other group, body or individual. We attempted to determine the root cause of the aircraft's failure to climb out and its subsequent descent into the ocean surf west of the Half Moon Bay airport.

Executive Summary:

While we do not yet have a final NTSB accident report, the preliminary report (Accident # WPR24FA073) is available, but has little useful information regarding the cause of the accident - only non-pilot eyewitness accounts indicating possible engine issues and confirmation of the reportedly ADS-B location track.

Assuming reliable and accurate track logs, N656TE reached ~250 ft Mean Sea Level (MLS), or approximately 180 ft Above Ground Level (AGL) upon departure. Eyewitness reports of a sputtering engine and subsequent loss of engine sound (even with an understanding that non-pilot eyewitness reports of airplane crashes are notoriously unreliable) supports the theory that an engine problem occurred which caused a partial power loss, progressing to a full power loss and the subsequent inability to maintain altitude.

After rotation and liftoff, the pilot quickly leveled off at the aforementioned 250 ft. MSL and then turned to the left at a rate approximately 2.5X that of a "standard rate" turn (one that takes 2 minutes to complete a 360 degree circle) and approximately 90 kts airspeed. This turn rate and speed implies a bank angle of approximately 30 degrees - not an emergency runway turnback maneuver. This suggests the engine was producing at least some power - enough to maintain altitude and airspeed. The subsequent assumed full power loss led to the inability to maintain altitude nor return to the airport or find a suitable landing area.

We did not find any smoking guns regarding the root cause of the accident. We were able to effectively rule out a number of possible root causes, leaving others as either more or less likely scenarios. We found some evidence of magneto damage to the magneto distributor contacts as well as damage to the left magneto engine attachment ears.

All evidence considered, the most likely scenario involves a partial ignition failure followed 20 - 30 seconds later by a full ignition failure. A second, less likely scenario involves a partial fuel blockage followed by a complete fuel blockage.

In either failure case, a partial power loss followed by a full power loss caused an unavoidable descent.

Full Accident Evaluation:

Actions:

We performed the following steps to examine the aircraft wreckage:

- Read the preliminary NTSB report for reference
- Examined all extant photographic evidence, including video
- Reviewed aircraft maintenance records, to the extent that they could be found
- Researched technical details of components unique to this aircraft
- Disassembled the aircraft engine
- Cleaned out sand/debris from the engine interior
- Examined all mechanical parts of engine
- Borescope engine interior
- Submitted magnetos and other ignition components to two ignition experts for evaluation

Observations (Positive and Negative):

- Both magnetos were serviced at or around the recommended 500 hour time in service
- Damage to the distributor portion of both magnetos consistent with possible partial or full power loss
- Due to the extensive damage to the airframe engendered by experiencing multiple tide cycles on a rocky beach, we were not able to extract any useful information from the airframe itself
- We did not observe any engine damage consistent with a sudden catastrophic engine failure
- We did not observe mechanical damage consistent with a partial power loss
- Analysis of extant Coast Guard video showed evidence of high impact damage to the airframe
- Aircraft components showed evidence of previous disassembly and removals (probably by NTSB) such as fuel filters, propeller governors and magnetos. Not all these components could be located for follow on inspection including the right magneto base
- Two simulations of the accident flight clarified the operating environment and conditions and confirmed that the flight track reported in the NTSB preliminary report was consistent with the likely flight path
- Departure in the opposite direction on runway 12 would have provide a safer environment for ditching in calmer water without reefs as well as providing additional first responder direct support
- We noted that equipment not necessary for conducting that flight was found in the wreckage. Baggage pods and the oxygen tank could have been removed to make the aircraft lighter and provide better performance. Additionally, the aircraft was carrying about 65% of its fuel capacity (200 lbs), well over three times the fuel needed to return to

Haward with IFR reserves. A lighter aircraft uses less runway, climbs better, lands slower and performs better than a heavy aircraft

Note: Absence of evidence is not evidence of absence.

Interviews:

- Interviewed recovery/SAR volunteer
- We conducted interviews with several participants of the search and rescue recovery volunteers and engaged in conversations with test pilots who previously flew with Lochie in N656TE.
- We talked to the builder, other maintainers and people familiar with N656TE to further understand the design considerations and operational methods and procedures under which the aircraft was operated.

Flight Simulation:

We conducted a simulation of the accident flight path in the Zeitlin COZY MKIV at 1,000 ft. MSL to further understand the flight path and pilot behavior. Mr. Briggs conducted a further flight path simulation at 250 ft. MSL in a multi engine aircraft to better understand the operating environment encountered with a low level departure.

Using an aircraft glide speed of 85 knots and an altitude of 250 feet with a light wind condition would likely have placed the aircraft approximately 3,500 ft. from the last data point on the NTSB graphic depicting the flight. This is close to where the aircraft was first documented by the Coast Guard approximately 60 minutes after the crash.

Neither a right turn or a straight ahead path would be consistent with a partial power condition in which the pilot believes he has a chance to return to the departure runway. A right turn would have taken the aircraft, unable to climb higher than 180 ft AGL, into rising terrain at night. A path straight ahead would have taken the aircraft further from the safety of land. The experienced pilot, familiar with the risks of ocean ditching, would not regard either of these as a preferred option.

Possible Root Causes - Details:

1. Spark Failure:

Spark ignition (SI) piston engines require three inputs to run - air, fuel and spark. The spark must occur at a specific crankshaft rotation position in order to produce power. There are many components of the spark system, including wires to each spark plug from each magneto and the spark plugs themselves. A loss of any one spark plug or spark plug wire would lead to an almost imperceptible loss of power, and as indicated, even a complete magneto loss of one magneto would only lead to an approximate 10% power loss.

N656TE's engine had two "Slick" brand magnetos which produce sparks on the eight spark plugs (two per cylinder). Each magneto produced sparks redundantly on four plugs each - one for each cylinder. A failure of a single magneto will cause the engine to run at slightly lower (~10%) power level, but will **not** cause a complete engine failure. The two magnetos are normally completely independent of one another, so a failure of one does not cause a failure of the other.

However, in addition to the two magnetos, **this** aircraft was equipped with an aftermarket G3i Series-2 electronic ignition system, which interfaces into both the left and right magnetos. The manufacturer's marketing literature claims that the unit enhances the magneto's performance by synchronizing the sparks, resulting in better fuel burn and easier starting.

Figure 1:
G3i Ignition System as installed, December, 2023

From the G3i website (https://www.g3ignition.com/benefits.html):

> "G3i module interfaces aircraft magnetos with electronic ignition allowing the aircraft engine to be operated more efficiently, with the added safety of the original magnetos as the back up system. If the aircraft experiences a total electrical failure or the G3i module is turned off, the magneto portion of the system comes back on line to keep the engine running. As for efficiency, electronic ignition does a much better job of burning all the fuel in the cylinders, resulting in more power and less fuel consumption.

An added benefit is a cleaner running engine, which is less likely to have cylinder problems.”

So if the G3i power is off or electrical power is lost, the two magnetos revert to their normal operating mode, meaning that while they would not obtain the advantages of the electronic ignition they would not stop operating normally (assuming that the magnetos themselves are working nominally).

However, there are caveats here with respect to the G3i system, which are that certain failures of the G3i ignition system exist that **can and may** cause spark stoppage from both magnetos. If the G3i system fails internally but is still supplied power, this **will** cause a complete ignition failure. Remediation of this failure (and reversion to normal “magneto” mode) requires the pilot to actively turn off the system to revert the ignition system back to normal "magneto only" mode. The aircraft builder indicated that he told the pilot that in the case of an ignition system failure, turning off the G3i would be appropriate to revert to normal magneto operations, but that there was no “emergency procedure” checklist to use.

To achieve this, the pilot must correctly perform a series of troubleshooting steps and subsequent corrective action.

1. The pilot must correctly determine that a G3i Series-2 failure is the cause of the engine partial or full power loss (this is determinative and non-trivial).

2. The pilot must switch the G3i system to the **"OFF"** position using the electronic ignition power switch (which on N656TE was on the top right corner of the instrument panel, away from the pilot). Only then would the magnetos revert to operating in their original mode.

Figure 2:
Passenger photo of N656TE IP on day of accident

3. Finally, if either of the magnetos does not operate correctly, the pilot must further diagnose which magneto is not functioning and switch **that** magneto **“OFF”**.

Note: Per the MFGs Service Bulletins (which are **not** regulatory, but only advisory), these magnetos should be serviced at the 500 hour mark (and according to the builder, they were). If the magnetos weren’t serviced after this time, then they would have had approximately 400 hours on them at the time of the accident -

approaching the recommended service period and in a time range where wear and failure become more likely.

Along with a possible internal failure of the G3i system causing an engine stoppage, the G3i uses the **left magneto points only** as the "trigger" for firing **all** the spark plugs - there is no trigger redundancy. If the left magneto points began to fail, all eight spark plugs could have begun to fire intermittently and only turning the G3i system **"OFF"** would have caused reversion back to normal "magneto only" operation.

After the pilot turns off the G3i system and successfully diagnoses the left magneto as misfiring, they could turn it **"OFF"** as well, allowing the engine to run using the right magneto only.

Israel found multiple NTSB accident reports involving failures of the G3i system which led to crashes or off-field landings. In these reports, the pilots indicated that the power failed and they were not able to determine in flight that the G3i failure was the cause. Subsequent analysis of the components did. Here are three notable examples:

- NTSB Accident Number: CEN24LA012
- NTSB Accident Number: CEN19LA326
- South African CAA Reference: CA18/2/3/9002 16 January 2012

We located the majority of the left magneto. We located the right magneto distributor block and drive gear but could not locate the bottom half of the right magneto, which includes the drive, primary and secondary induction coil. The gear connections to the accessory case for both magneto locations appeared intact, however the left magneto case attachment ears were broken off at the time of our inspection. This is likely due to surf action but the actual cause is undetermined.

A mechanic recommended magneto gasket maintenance for a minor oil leak in December, 2023 and the mechanic provided two gaskets to the aircraft owner. We don't know if those gaskets were replaced or if any magneto maintenance was performed.

Given the magneto condition(s) neither we nor the ignition experts consulted were able to

Figure 3:
Distributor contact damage

evaluate all components of the interior of the magnetos. We were able to determine that the distributor electrode brush contacts were substantially damaged as compared to new ones. This damage could have been caused by lack of magneto maintenance or by excessive energy transfer from the G3i system, which puts out ~3X the energy of a standard magneto, but passes that energy through the magneto components.

You can see the damage to the distributor contact areas in Figures 3 through 6.

Figure 4:
Closeup of distributor contact damage

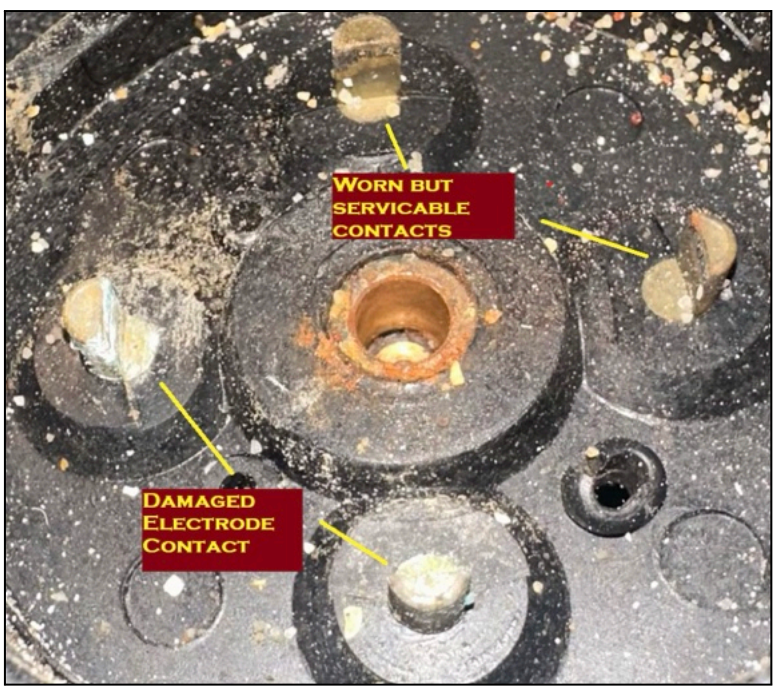

Figure 5:
Two distributor contacts damaged

Both distributor caps had been previously disassembled and inspected with the exposed components placed unassembled and loose with the wreckage prior to our examination, with no labeling. Therefore we do not know which cap was associated with which magneto.

Figure 6:
Second distributor cap - worn, but more serviceable contacts

This information and analysis suggests that either a left magneto or G3i electronic ignition system failure could account for a large power loss as well as a subsequent total loss of power. An ignition system failure of these kinds is the most likely accident cause (although even with this knowledge, the probability of this being the cause may still only be in the 50% - 80% range).

2. Fuel Supply Failure:

The next component of the triad of requirements for an SI engine is the fuel supply. The COZY MKIV stores fuel in tanks integral to each side of the fuselage. The fuel travels from the tanks (one is used at a time) through a coarse filter and tubing to the engine compartment where it passes through hoses to a fine filter, then an electric auxiliary fuel pump, to a mechanical engine driven fuel pump, through a fuel flow meter to a fuel distribution block and then through four small metal fuel lines to fuel injectors on each cylinder. Any of these components can be partially or fully clogged or blocked which will then partially or completely restrict fuel flow to the engine. This would impair operation and power output.

At the time of the accident, the aircraft had approximately 17 gallons of fuel in each tank as evidenced from the analysis of a photo taken by the rear passenger. Fuel flow indicated 8.1 GPH at 2,650 RPM, which is normal for a Lycoming O-360. Fuel pressure was 25psi. The electric backup fuel pump did not appear to be turned on. Given the fuel load upon landing, it's unlikely the pilot would have taken on fuel at Half-Moon Bay - a potential source of contamination. The weather conditions did not include precipitation so it's unlikely that water was introduced through leaky fuel caps.

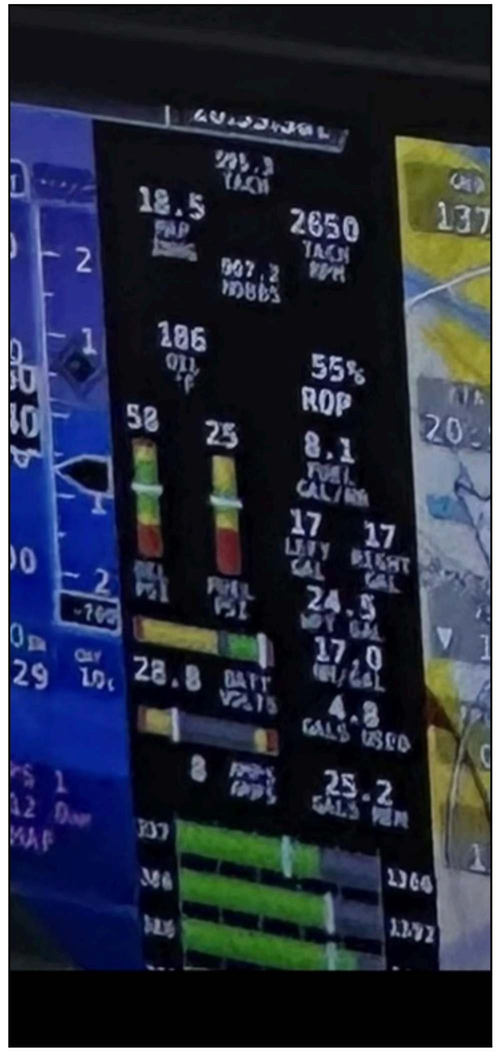

Figure 7:
Screenshot of fuel information

A partial blockage of a major fuel feed component could restrict fuel to all four cylinders, which would show on the instrument panel as a decrease in fuel pressure and fuel flow. This can sometimes be mitigated by a throttle reduction which causes less air intake, but obviously with a power loss of varying degrees. Dealing with this only a few seconds after takeoff would be a major pilot workload, particularly at night and with 3 passengers causing distractions.

Key components such as the fuel servo filter necessary to find fuel blockage were not available to us and could not be located in the aircraft remains since they had previously been removed by investigators.

A partial or complete blockage of one (or more) of the fuel lines to the individual cylinders would have a similar effect as an overall blockage - at wide open throttle as at takeoff, one or more cylinders may stop producing power as they would not be getting enough fuel to run properly. This would entail a large power loss, either due to the cylinder not running or the need for the pilot to reduce throttle settings to allow the cylinder to run with the fuel available.

A progressive blockage of one or more fuel injector lines or of the major fuel delivery hoses, or possibly a fuel system disconnection that precluded the required fuel from getting to the engine could cause the behavior evidenced by the radar/ADS-B track.

We find a fuel issue of some sort to be one of the more likely scenarios, as the effects of a failure matches the aircraft's behavior and fuel blockage is not an unknown failure mode. This does not mean that we have confidence that this is the cause of the accident - only that it is one of the more likely of the available explanations.

3. **Air Supply Failure:**

   The last component of the triad of requirements for an SI engine is air, which is drawn through an air filter to the fuel injection throttle body, through four intake tubes to each of the four cylinders on the engine and then through the intake valves in the cylinder head into the combustion chamber. While the air filter was missing, it was not of a type that could disintegrate and be ingested into the airway, blocking it. There was no blockage in any of the components that take in induction air and feed it to any of the cylinders. Due to the lack of anything impeding airflow to each of the cylinders, a lack of combustion air to the cylinders is not a likely accident cause.

4. **Engine Mechanical Failure:**

   Aircraft engine failures are, after pilot error, one of the more likely causes of aircraft accidents. A mechanical failure of a Lycoming piston engine would involve breakage of a critical mechanical part, such as but not restricted to the crankcase, crankshaft, camshaft, accessory case gears, propeller extension or propeller mounting, pistons, connecting rods, pushrods, valves, main bearings or piston pin bearings.

   Our examination of the engine, which involved cleaning the exterior and interior to the maximum extent possible of the sand and contamination that was inside and then disassembling as much of the engine as possible, allowed us to see (either from the outside or using a borescope) essentially all major components of the engine. We were able to remove one cylinder and get inside the crankcase, which was pristine, even after submersion in salt water and over a year sitting unpreserved (although washed with fresh water). While there was substantial corrosion in the cylinders, freezing the pistons in place, we found no instance of any mechanical breakage or failure, much less a failure that would lead to either a partial or total power loss.

   We were able to recover a small amount of oil from the engine and we submitted it to Blackstone Laboratories for an analysis. Other than a substantial amount of sodium from the salt water in which the engine was immersed, there was no indication of any issue with the oil or metals in the oil.

   Engine mechanical failure is not a likely accident cause.

5. **Control System Failure:**

   Catastrophic control system failures of canard composite aircraft are almost completely unknown, particularly when in normal flight conditions. Given the flight path information indicating an aircraft under control for the extent of the trackable path there is no evidence of a control system failure.

   Control system failure is not a likely accident cause.

6. **Airframe Failure:**

   Catastrophic airframe failures of canard composite aircraft are almost completely unknown, particularly when in normal flight conditions. Given the flight path information indicating an aircraft under control for the extent of the trackable path there is no evidence of an airframe structural failure.

   Airframe failure is not a likely accident cause.

7. **Co-Pilot/Passenger Operational Error:**

   To the extent that we know which of the three other people in the aircraft was in the co-pilot's seat (front right), since there are a full set of aircraft controls on the right side it is possible that the passenger created control inputs that caused the accident. As with #5 and #6, however, there is no evidence of loss of control of the aircraft, given the smooth and controlled turn to the left and the straight path at 250 ft. MSL along the shoreline. It is certainly possible that the passenger in the co-pilot's seat imparted some control system input at some point late in the flight that exacerbated the situation, but we have zero evidence of that.

   Co-Pilot operational error is not a likely accident cause.

8. **Pilot Operational Error:**

   The pilot was a very experienced test pilot and all who knew him indicated that he was extremely competent. While it is always possible that even the most experienced and qualified pilot can commit a major operational error in control or judgment, in this case this is highly unlikely.

   Given that the aircraft was in control for the extent of the trackable path, a pilot operational error (Loss of Control for any reason) is not a likely accident cause.

9. **Medical Emergency:**

   In all aircraft accidents, a medical issue that prevents the pilot from safely flying the airplane must at least be considered. Generally, a medical emergency involves the loss of control of the aircraft. Given this pilot's age and health, a medical emergency was extremely unlikely (although not impossible).

Given the fact that the airplane's track indicates that it was under control for all of the trackable flight path, a loss of control of the aircraft due to a medical emergency is not a likely accident cause.

10. Other?

While there are myriad other possible failures in any aircraft, these are the main ones that we believe might have been causal. We have no evidence to suggest anything else.

Conclusion:

Time and resources required a limit to what could be dedicated to this inspection and analysis. We invested approximately 15 man-days into the on-site inspection as well as follow-on research, phone calls, interviews and documentation.

We understand that our inability to determine with finality the root cause of this crash is unsatisfying and upsetting. A control error or engine problem, when "up and away" at higher altitudes can be anything from mildly annoying to a large workload change to a dangerous condition, but **any** failure of **any** type when close to the ground just after takeoff or just prior to landing is always more critical, as there's little time and limited space options for the pilot to debug a failure and respond appropriately.

This pilot was engaged in one of the most demanding flight operations imaginable. Single pilot, single engine, heavy aircraft, experiencing catastrophic power loss at low altitude at night with possible marine layer instrument meteorological conditions in an aircraft equipped with a non-standard ignition system augmentation.

We believe that the most likely scenario involves the ignition system with the fuel system a more distant second possibility. This will only ever be speculation since it cannot be confirmed with the available resources.

Thanks to all of those that supported this effort.