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1.0 Applicability and Scope

To define potential causes of partial loss of engine power leading to the crash of N230ME on 3rd June 2008, and to define and report findings of investigations necessary to determine cause.

2.0 Engine and Airframe

Engine: G-190-A1A S/N 06-002

DEM system: V2 DEM system with fuel pump control

Airframe: Mistral Piper Arrow III, registration N230ME

Engine TTSN: 266.9 hrs

3.0 Accident Circumstances

The accident occurred within one mile of Palatka airfield at 09:36LT on 3rd June 2008.

Prior to the final flight, the pilot flew from DeLand to Palatka with block time 08:14 LT to 09:12LT. The flight was problem free.

The pilot refuelled at Palatka airfield and re-started the engine at 09:27LT.

Prior to take-off a run-up check was completed successfully including:

Check of each fuel pump	OK
Check of each ECU	OK
Check of propeller governor	OK
Check of fuel selector position	Left
Check of water in fuel / fuel type	Wing tanks only

Take-off from RWY 17 at 09:34LT.

The pilot reported a gradual decline of power shortly after take-off and at circa 200ft, with propeller speed reducing to 2080rpm, tried to execute a 180° turn to return to airfield. Note there were no opportunities to land ahead due to buildings and trees. The aircraft started to lose altitude and overflew several buildings and powerlines before hitting trees.

Both wings were detached and the fuselage hit the ground in a nose down attitude, coming to rest on the left side. The pilot was able to free himself from the aircraft with assistance. He suffers only from minor cuts and bruises.

4.0 Potential Causes of Power Loss / Investigation

This section presents generic causes of loss of power due to engine and associated system malfunctions, as a framework for investigations.

Checks which have been completed are indicated with findings and marked ñOKò if the part or system is found to be fully operative. Those checks which are still to be completed are marked ñTBCò

4.1 Fuel System

Cause	Check	Where	Result
General	Loss of fuel pressure ï check DEM data	DeL	OK ï 5bar
Fuel pump failure	Test fuel pumps Check electrical system	In Situ In Situ	OK OK
Vapour lock / de-priming	Measure residual fuel in circuit	In Situ	OK
Fuel Contamination	Water content Dirt content ï check blocked filter	In Situ In Situ	OK OK
Incorrect Fuel	Test fuel in gascolator	In Situ	OK
Injector failure	Test injectors	GVA	TBC
Findings: The ECU data indicates that the fuel pressure in the system was stable at 5 bar until circa 40 seconds after engine stoppage, when the pilot turned off the data recording system. Fuel samples from the gascolator showed no indication of contamination or water.			

4.2 DEM System

Cause	Check	Where	Result
Electrical Power Loss	Check ECU data Battery condition Wiring condition Circuit breakers / switches Alternators	DeL In Situ In Situ In Situ GVA	OK OK OK OK TBC
Loss of ECU function	Check ECU data ï EGT Check ECU log - Dual/Solo, Errors Test ECUs	DeL DeL GVA	OK OK TBC
Loss of injector function	Test injectors	GVA	TBC
Loss of ignition function	Inspect plugs Test ignition	GVA GVA	TBC TBC
ECU harness condition	Check for broken connectors, wires	In Situ	OK

4.3 ECU Data

ECU data is presented in Appendix 2. The data shows that all major engine parameters were within expected ranges for the whole duration of the flight, with the exception of propeller speed which is slightly lower than normal (below 2100rpm instead of 2150-2250rpm for take-off and climb).

The engine stops abruptly on impact at 09:36:21 ECU time and several parameters are recorded for the next circa 40 seconds, indicating fuel pressure of 5 bar, and EGTs cooling off normally. The engine oil and water temperatures remain stable at 87°C and 92°C respectively.

4.4 Induction System

Cause	Check	Where	Result
General	Check DEM data - MAP	DeL	OK
Air filter blockage	Check filter condition	DeL	OK Impact damage
Loss of throttle control	Check mechanical connections	In Situ	OK
Intake icing	Loss of MAP	N/A	N/A
Findings: The ECU data indicated approximately 1000hPa manifold pressure for the duration of the take-off and flight until engine stoppage, where it rises to ambient pressure.			

4.5 Exhaust System

Cause	Check	Where	Result
Increased backpressure	Check primary manifold condition	In Situ	Impact damage, otherwise OK
Increased backpressure	Check muffler condition	In Situ	Blocked
Findings: Primary manifold (IN625) and intermediate exhaust (SS321) internally in very good condition (TTSN 341 hours). Impact damage to external envelopes. Muffler blocked by collapsed internal perforated tube and packing material. Reduction of exit area circa 75%. Fitted 7/3/2008. TTSN 169.7 hours. The liner material is SS 321, with stainless steel strand / basalt packing material. See Appendix 1			

4.6 Engine Block / Gearbox

Cause	Check	Where	Result
Loss of compression	Check compression (leak test) Check engine internals	GVA GVA	TBC TBC
Loss of lubrication	Check DEM data ï Oil Pressure Check engine internals Test oil and filter	DeL GVA DeL	OK ï 6bar TBC TBC
Loss of cooling	Check DEM data ï Temperatures	DeL	OK ï 92°C
Gearbox failure	Inspect gearbox	GVA	TBC
Absorber failure	Inspect absorber	In Situ	Impact damage
Findings: The absorber rivets have sheared on the rear face, resulting in abnormally high play, but still ensuring torque transmission. This is assumed to be impact damage due to the prop strike. The engine turns freely and chamber seals and chamber condition appear OK. Coolant and oil systems were full and at normal levels after recovery.			

4.7 Propeller

Cause	Check	Where	Result
General	Indications of power on impact	In Situ	See below
Coarse pitch	Test governor	DeL	OK
Findings: The blade root fractures and spinner damage indicate rotation at impact. The governor has been tested and verified as airworthy.			

5.0 Conclusions

The primary cause of the accident is concluded to be partial loss of engine power immediately after take-off.

The partial loss of power was caused by the collapse of the muffler inner tube and packing material, which subsequently blocked the muffler exit and increased backpressure in the exhaust system. High exhaust backpressure has been demonstrated to substantially reduce engine output power.

In all other respects the engine was fully operational until impact.

The engine, ECU and fuel system components will be tested on a dynamometer test bench after inspection of the PSRU for impact related damage and replacement of the torsional absorber which was damaged by the propeller strike on impact.

6.0 Appendices



Appendix 1:

Looking into rear of exhaust muffler.

The inner perforated tube has collapsed and is obstructing the muffler exit together with the packing material.

The effective exhaust exit area is reduced by approximately 75%.

Appendix 2 ï ECU Data

