FINAL REPORT

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The Inspector-on-Call (IOC) for the 20 August 2008, Mr. Graham Liddy and Mr. Leo Murray responded to this notification and attended at the scene. In accordance with the provisions of SI 205 of 1997, the Chief Inspector of Air Accidents, on 16 March 2009, appointed Mr. Thomas Moloney as the Investigator-in-Charge (IIC) to conclude the Investigation into this Accident and prepare a Synoptic Report.

Aircraft Type and Registration:	Piper PA 28-151, EI-WRN
No. and Type of Engines:	1 x Lycoming O-320-E3D
Aircraft Serial Number:	28-7615212
Year of Manufacture:	1976
Date and Time (UTC):	20 August 2008 @ 12.58 hrs
Location:	Trim Airfield (EITM), Co Meath
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 0 Passengers - 0
Nature of Damage:	Substantial
Commander's Licence:	Commercial Pilot's Licence (Aeroplanes)
Commander's Details:	Male, aged 28 years
Commander's Flying Experience:	4,472 hours, of which 280 were on type
Notification Source:	Trim Airfield owner
Information Source:	AAIU Field Investigation

SYNOPSIS

The planned flight was from Trim Airfield, Co. Meath to Weston Airport. In the early stages of the climb out from Trim, the engine suddenly ceased producing power. The Pilot applied carburettor heat and power was restored for a number of seconds. However, the engine then stopped completely and the aircraft force landed in a field of barley close to the airfield. The aircraft was substantially damaged. The Pilot and his passenger were taken to hospital but they were not injured. There was no fire.

FINAL REPORT

1. FACTUAL INFORMATION

1.1 History of the Flight

The Pilot had intended to conduct a flight from Trim Airfield (EITM) to Weston Airport (EIWT) with one passenger. On arrival at Trim Airfield at approximately 12.00 hrs, the Pilot inspected the runway on foot. He stated that he found it to be hard, firm and serviceable with no standing water, but he also stated that the grass was wet with dew. He next opened the gate between the grass secondary apron and the runway. He completed a check of the engine, checked fuel and oil levels and he also checked the fuel for water content. The aircraft fuel tanks were full. He then started the aircraft and taxied from the secondary apron through the gate to the holding point stop line short of the runway. He shut the engine down and carried out a walk round inspection as per the Pilot Operating Handbook checklist. Having closed the gate between the secondary apron and the runway, he re-boarded the aircraft, performed all the required checks and re-started the engine. The aircraft was taxied down the runway for a departure from runway (RWY) 28, since the wind favoured that runway. The Pilot selected the left fuel tank for the initial start-ups and taxi out. The selection of carburettor heat during ground taxiing is not normally recommended and accordingly the Pilot did not use carburettor heat during the taxi. On arrival at the end of the runway, he taxied off to the right side of the runway to perform engine run up checks in accordance with the pre-take-off checklist. He changed to the right hand fuel tank prior to the run up.

The Pilot stated that while performing the carburettor heat check, he left it on for 10 seconds, as he was conscious of the fact that there might be carburettor icing and "*that it affected the aircraft type that he was operating"*. He stated that the engine operated normally and showed no signs of icing.

Following completion of all checks, the Pilot lined up on RWY 28 for departure. He advanced the throttle to full power and held the aircraft on the brakes for a few seconds to check if all engine parameters were normal. He released the brakes and began the take-off roll. This was normal and the aircraft became airborne just over half way down the runway. He levelled the aircraft and accelerated in ground effect for the remainder of the runway. On reaching 80 mph he started to climb with a shallow right turn for noise abatement purposes.

The Pilot stated that shortly after the climb out began "*the engine ceased producing power like someone had closed the throttle"*. He stated that his hand had been firmly on the throttle quadrant all the time since take-off, with the throttle in the fully open position and the mixture in the full rich position. He immediately lowered the nose to find a field and at the same time applied carburettor heat on. After doing this engine power was restored and the aircraft began to climb again. However, after about five seconds the engine again stopped producing power just as the aircraft cleared a line of trees. The Pilot stated that "*the engine had failed and came to a complete stop"*. He immediately lowered the nose in order to land in a field beyond the line of trees. He transmitted a Mayday call on the Trim Airfield frequency.

The Pilot had selected a 25° flap setting as per the short field take-off performance requirement. He delayed selection of 40° flap as long as possible as he felt that this gave him the only possibility of arresting the aircraft's high rate of descent. He flared the aircraft as normal while selecting Flap 40 and he stated that this seemed to decrease the descent rate. The aircraft struck the ground in a barley field and the Pilot recalled that it continued moving *"for a second or two"* and that it *"yawed on the ground after impact"*. The Pilot told the Investigation that the main wheels touched down before the nose wheel with the aircraft in a nose-up attitude.

Photo No. 1 shows the flight path of EI-WRN following its departure from RWY 28 until the impact point in the field of barley.

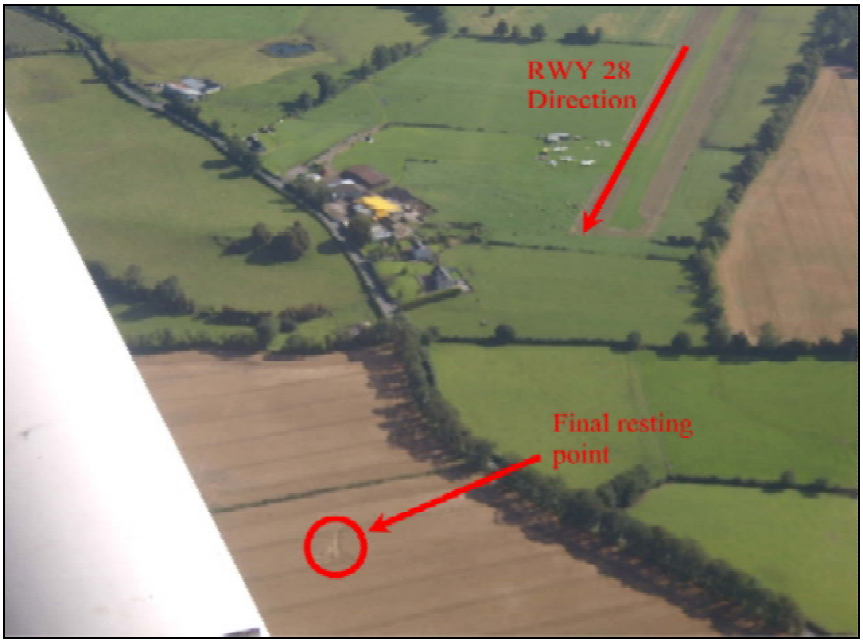

Photo No. 1: Final flight path of EI-WRN

The aircraft came to a stop in the field resting on its fuselage and left wing on a heading of 145° magnetic (**Photo No. 2**).

Photo No. 2: EI-WRN final position following forced landing

The Pilot closed the throttle and mixture levers, switched off the master switch, opened the door and evacuated his passenger and himself. Shortly afterwards, three members of Trim Flying Club arrived at the scene. One of them asked the Pilot if he had switched off the fuel selector. He stated that he had not so he returned to the aircraft and switched it off. Thereafter, he again returned to the aircraft and removed all the paperwork and his headset. The Pilot and his passenger were taken to Navan hospital by ambulance and were released a short time later.

1.2 Aerodrome Information

Trim Airfield is a privately owned airstrip situated 2.5 NM northeast of Trim. It has a single 580 metre grass runway orientated east-west (designated RWY 10/28).

1.3 Weather Information

The Aviation Services Division of Met Éireann prepared an aftercast for the location and time of the accident:

Meteorological Situation: *The Trim area lay in a Southwesterly flow with a weak occluded front approaching from the Southwest.*

Meteorological conditions at time of accident: *(**Note:** Due to the absence of an actual weather report from the Trim area, the following values represent the best approximation of likely conditions at the time of the incident)*

Wind:	*200°/5-8 Kts*	
Cloud:	*SCT 1,500FT BKN 2,500-3,500 Ft*	
Visibility:	*20-30 Km*	
Weather:	*Possible light rain circa time of the incident (Radar imagery shows very light precipitation close to the region)*	
Temps:	*Air temperature*	*16ºC.*
	Dew point temperature	*12ºC.*
Freezing Level:	*7 - 8,000 ft*	
Pressure:	*1007 hPa QNH*	

Additional comment re carburettor icing:

The air temperature of 16ºC combined with a dewpoint of 12ºC represents a serious risk of carburettor icing at any power.

Note: The Pilot informed the Investigation that there was no rain present in the area at the time of the accident.

1.4 Aircraft Information

The Piper PA 28-151 Cherokee Warrior is a single-engine fixed gear monoplane of all metal construction with low semi-tapered wings. EI-WRN was powered by a four-cylinder, Textron Lycoming O-320-E3D (Serial No. L34259-27A) horizontally opposed engine rated at 150 hp, driving a Sensenich 74DM6-0-58 fixed-pitch propeller (Serial No. A57357).

Fuel is held in two wing tanks, with a total capacity of 189 litres (50 USG). Fuel is drawn from either the Left Tank or Right Tank (as selected by the fuel tank selector control) and fed to the carburettor via a fuel strainer and engine driven pump. An auxiliary electric fuel pump is provided in case of failure of the engine-driven pump.

1.5 Maintenance

The aircraft had been issued with a Certificate of Airworthiness by the Irish Aviation Authority on 17 July 2008.

The aircraft was maintained by a Licenced Maintenance Engineer based at Waterford airport. The most recent maintenance checks had been a 50-hour inspection at 7,857 airframe hours signed off on 12 February 2008 and an annual inspection at 7,888 airframe hours for which a Certificate of Release to service was issued on 14 July 2008. The annual inspection was carried out in accordance with the UK CAA Light Aircraft Maintenance Schedule (LAMS) A/1999 Issue 2. Additional works were carried out in conjunction with the annual inspection including inter alia radio and instrument checks and calibration, cylinder compression checks, engine oil and filter replacement, Airworthiness Notices checks and Airworthiness Directives checks. Following the flight preceding the accident flight, which had been flown on 10 August 2008, the total airframe hours logged were 7,893.

The engine had been overhauled with a certification date of 11 August 2004 and it was subsequently installed and put into service on EI-WRN on 07 September 2004. At the time of the Annual Inspection carried out on 14 July 2008, the engine had completed 1,266 hours since overhaul and following the pre-accident flight on 10 August 2008 the log book entry was 1,270 hours. The Investigation noted that there were minor discrepancies between the times recorded in the airframe and engine logbooks. However, these are not considered to be significant with respect to the accident.

1.6 Damage to aircraft

The aircraft was substantially damaged in the accident, possibly beyond economic repair. The nosewheel had detached at impact and the port main wheel was found detached, underneath the port wing, still attached to the aircraft by the brake hose. The port flap was badly damaged. The top skin of the port wing around the landing gear attachment point was buckled and the fuselage longerons aft of the firewall were damaged. The engine firewall was distorted. One of the propeller blades was substantially bent back while the second blade had a slight rearward distortion.

1.7 Technical Examination

Upon arriving at the accident site, the Investigation began a technical examination of the aircraft. The fuel selector was found selected to OFF. The throttle was selected to IDLE, the mixture was selected to LEAN and the carburettor heat was ON. The flaps were extended to 40° (the maximum setting). The barley crop was damaged at the point of impact, however there was no damage to the crop behind the impact point. The impact trail was measured at 21.9 metres in length on a heading of 260° magnetic. The aircraft had come to rest on a heading of 145° magnetic. The port fuel tank was full and there was also a substantial quantity of fuel in the starboard tank.

The upper engine cowling was removed by the Investigation and the engine was inspected for damage. The engine and its bearer were canted down at the front. With the force of the impact, the muffler had been forced upward causing the exhaust pipe on No. 2 cylinder to partially constrict at its bend. The fuel line between the electric fuel pump and the engine pump was opened at the electric pump end but no fuel was evident. However, there was a smell of fuel on the ground in the area beneath the main fuel filter.

1.8 Tests and Research

The aircraft was removed to an adjacent farmyard for further examination. The lower cowling was removed to provide access to the fuel filter. There was a spring loaded valve mechanism on the bottom of the fuel filter, the purpose of which was to allow the fuel to be checked daily for water content. The fuel filter was removed and the drain valve mechanism was dismantled. The fuel line between the electric fuel pump and the engine driven pump was opened at the electric pump end. No evidence of fuel was found. The Investigation found that the drain valve on the fuel filter was left in a partially open position as a result of the heavy ground impact. There were no contaminants on the fuel filter mesh. The fuel line was checked to ensure there were no blockages between the selector valve and the filter. There was an adequate flow from the selector valve. A sample of fuel was taken at that stage.

The propeller was pulled through by hand a number of times. The engine was found to rotate with normal resistance and with no abnormal noises. Cylinder compression was normal. There was no significant external damage to the engine and all the spark plugs and their leads were in place.

The partially-opened valve on the fuel filter was closed and the filter was re-assembled and replaced. The engine was primed once and then started without difficulty on the first attempt. The power was limited to idle during this ground run due to the damage to the propeller blades and the engine bearer.

2. ANALYSIS

The impact point and the debris trail were examined by the Investigation. The nose wheel had detached and remained at the impact point. The engine and its bearer were found canted down from the front. This was as a result of the nose wheel impacting the ground and causing a large, downward force to act on the engine and bearer. When the engine ceased producing power the Pilot lowered the nose in order to maintain airspeed. The flaps were found at their maximum setting of 40°. Although the Pilot stated that he had held off extending the flaps to their maximum setting for as long as possible and that he felt that their extension had helped arrest his rate of descent, analysis of the impact point and debris trail indicated a nose-down attitude at impact.

However, the Pilot has stated to the Investigation that in his opinion the aircraft was not in a nose-down attitude at impact.

There were no propeller slash marks found along the debris trail. This indicates that the propeller was probably not rotating under power at the time of impact. This is further substantiated by the fact that only one of the propeller blades was bent to a significant degree.

The fact that the drain valve on the fuel filter had been left in a partially open position as a result of the heavy ground impact explains why there was no fuel present in the line between the electric and engine driven fuel pumps. However, there was a smell of fuel in the area of ground beneath the fuel filter. There was no evidence of fuel contamination.

The engine was pulled through by hand without apparent problem, started without difficulty and ran successfully. This demonstrated that there were no engine mechanical problems. The fact that the engine started on the first attempt indicates that there was fuel in the carburettor bowl and that the possibility of the engine running out of fuel can be eliminated.

The Met Éireann aftercast specifically commented on the fact that the combination of the air temperature and dewpoint temperature at the time represented a "*serious risk of carburettor icing at any power*", (see **Figure No. 1**). Furthermore after the accident the Pilot reported that there was no standing water on the grass runway but that the grass was wet with dew.

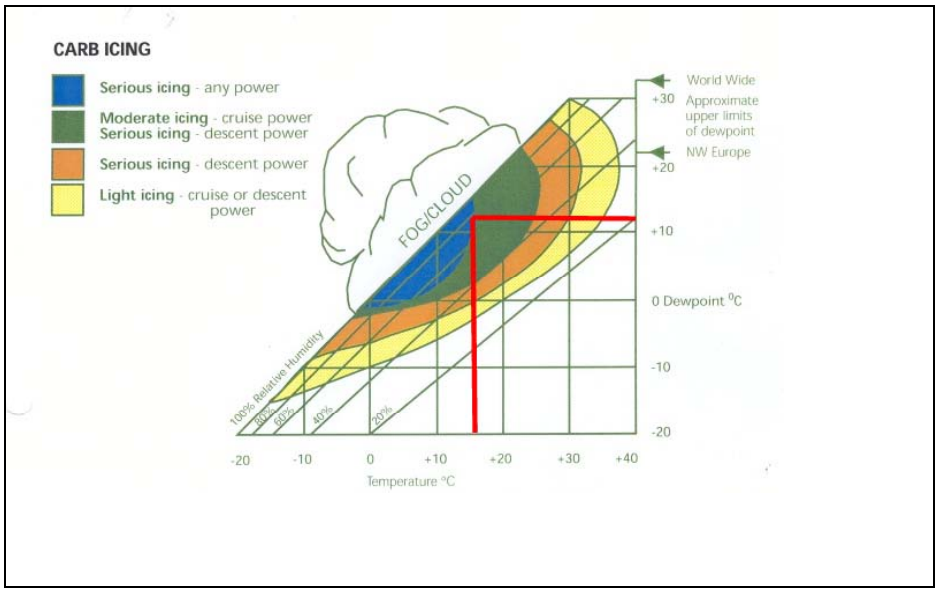

Figure No. 1: Carburettor Icing Temperature/Dewpoint Graph

The two red lines in Figure No. 1 represent the air temperature of 16ºC and dewpoint temperature of 12ºC as provided by the aftercast. The point at which they intersect illustrates that the conditions present at the time of the accident presented a risk of serious icing at any engine power setting.

Carburettor icing is caused by the sudden reduction in temperature due to fuel vaporisation and the reduction in pressure at the carburettor venturi. The reduction may be as much as 20 to 30ºC and results in moisture in the induction air freezing.

The ice gradually builds up constricting the venturi and, by increasing the fuel/air ratio, causes an excessively rich mixture, rough running and a decrease in engine power. Reduced power settings are more conducive to icing in the throttle area because there is a greater temperature drop at the carburettor venturi and the partially closed butterfly can more easily be restricted by the ice build-up.

The aircraft taxied from its parking position on the secondary apron, initially to the runway holding point and subsequently to RWY 28 run-up point. During this significantly long taxi at low power, it is likely that ice started to build up in the carburettor, given the atmospheric conditions present. The damp grass would have exacerbated these conditions, since the propeller would have kicked up further moisture into the air. This in turn would have raised the relative humidity of the air around the carburettor intake, which is located on the lower right cowling behind the propeller.

Although the Pilot did select Carburettor Heat on for a period of 10 seconds during the pre-flight run-up checks, it is likely that this did not fully clear the carburettor of ice. In 1997, the Irish Aviation Authority issued an Aeronautical Information Circular No.11/97, which notes in Para 5.5 "Immediately prior to Take-off" that induction icing can occur when taxiing at low power or when the engine is idling. It goes on to state that if the weather conditions are conducive to icing then Carburettor Heat should be selected before take-off for a sufficiently long enough period to remove any accumulation, which may have occurred. It further states that if an aircraft is kept at the holding point in conditions of high humidity it may be necessary to run up the engine to take-off power more than once to clear any ice which may have formed.

On the take-off run, the interaction of the shock waves created by the propeller tips with the wet grass is likely to have further increased the relative humidity in the area of the carburettor intake again raising the probability of icing.

After the initial loss of power in the climb out, the Pilot selected Carburettor Heat on and this restored engine power for a few seconds. However, the engine then stopped and the pilot had no option but to force-land in the field. It is probable that this application of Carburettor Heat did melt some ice, thus forming water vapour which displaced the already limited air supply in the fuel air mixture, and that this resulted in a fuel/air mixture so rich that ignition was impossible and the engine failed completely.

Unfortunately the application of carburettor heat after the formation of significant levels of ice has formed in the venturi can have the effect of causing the engine to stop. Thus it is essential that carburettor heat be applied prior to the onset of icing, to prevent its formation. The IAA Aeronautical Information Circular No. 11/97 and the UK CAA Circular AIC 145/1997 (Pink 161) (see http://www.nats-uk.ead-it.com/aip/current/aic/pink/EG_Circ_1997_P_145_en.pdf) contain useful information of the hazards associated with carburettor icing and should be studied by all pilots of piston-engined aircraft.

3. CONCLUSIONS

(a) Findings

1. The Pilot was properly licenced for the flight.

2. The aircraft was properly registered in the State and was properly maintained with a valid Certificate of Airworthiness at the time of the accident.

3. The aircraft had sufficient fuel and oil on board for the intended flight. The fuel used was of the correct grade and no evidence of contamination was found.

4. Shortly after the accident, the engine was started without difficulty by the Investigation and ran satisfactorily.

5. No engine or fuel system defects were identified which could have caused the loss of power.

6. The air temperature and dew-point temperature combination on the day in question represented a serious risk of carburettor icing at any engine power setting.

7. At the time of take-off, although the grass runway was firm with no standing water, the grass was wet with dew.

(b) Probable Cause

The aircraft suffered an engine power loss as a result of carburettor icing upsetting the fuel / air ratio to the engine.

4. SAFETY RECOMMENDATIONS

This Investigation does not sustain any Safety Recommendations.

- END -