FINAL REPORT

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In accordance with the provisions of SI 205 of 1997, the Chief inspector of Accidents, on 28 June 2003, appointed Mr. John Hughes, Inspector of Accidents, as the Investigator-in-Charge to conduct a Field Investigation into this occurrence.

Aircraft Type and Registration:	Rutan Long-EZ, EI-CMR
No. and Type of Engines:	1 x Avco Lycoming O-235 flat four Piston engine
Aircraft Serial Number:	Homebuilt
Year of Manufacture:	2003
Date and Time (UTC):	28 June 2003 @ 15.30 hrs
Location:	Bunmahon, Co. Waterford.
Type of Flight:	Private, Experimental
Persons on Board:	Crew-1 Passenger-1
Injuries:	Crew-Nil Passenger-Nil
Nature of Damage:	Surface scratches to wings and fuselage
Commanders Licence:	CPL
Commanders Age:	Male, aged 36 years
Commanders Flying Experience:	1,193 hours of which 7 hours were on type.
Information Source:	Waterford ATC and Tramore Gardai. AAIU report form submitted by Pilot

SYNOPSIS

While flying off the coast of Waterford at Bunmahon, the pilot experienced rough running of the aircraft's engine. At approximately 600 feet above mean sea level (AMSL) the pilot levelled the aircraft from a climb, turned on the fuel pump, switched the fuel tanks and quickly turned on the carb heat. There was no improvement in engine performance. The pilot observed a field large enough to make a landing. He landed with little damage to the aircraft and no injuries. He used his radio to report the incident to the control tower at Waterford Airport. The aircraft also suffered an engine failure on a successive flight. Possible causes in both cases were rich carburettor settings and poor magneto spark with perhaps a case of induction icing during the incident flight.

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1. FACTUAL INFORMATION

1.1 History of the Flight

The pilot had completed all the power checks on this aircraft, which included a check above 2,400 RPM. He said that he took off with his passenger towards the Bunmahon area approximately 12 miles from Waterford. His passenger, a Dutch visitor, was engaged in taking aerial photos and there were also friends of the pilot, taking pictures, on the cliffs at Bunmahon. He headed out to sea in order to stay away from them and there descended to 300 ft AMSL. He turned and climbed to about 600 ft over land. He did five or six cycles of descending and ascending.

On the third last one he noticed that after he turned off the Carb heat and put in full power he got a kick from the engine (i.e. no immediate reaction from the engine at first). He descended and then climbed up again and this time, decided to put the throttle in more slowly. He climbed again to 600/700 ft. When he levelled off he put on the Carb heat and brought the engine back to descent speed (1,600 RPM) to start the descent again.

During the penultimate climb out when he put in the throttle he put it in slower. The response from the engine was much better than on the previous occasion but still not perfect. He climbed up again to descend for the final cycle. He descended with the Carb heat on again. When he turned off the Carb heat and put in the throttle slowly, the engine began to splutter again. This got worse when ascending from 300 ft to 600 ft. He turned left over the water, and returned towards the town heading for the adjacent beach. He manoeuvred the aircraft to get as much climb as possible in order to land on the beach.

He got a little further than the beach, eased off and got a little more than Vy airspeed (speed for best rate of climb). He turned off the Carb heat, switched on the electric fuel pump and changed the fuel tank in use. This made no difference. He levelled off at 600 ft as the engine got worse. The main landing gear being fixed on this aircraft, he brought the nose landing gear down again, for slow flight.. He was now perpendicular to the coastline. He picked a field less than a mile from the town. He turned into the field and at this stage the engine stopped altogether. He extended the landing airbrake, as no flaps are installed on this aircraft type. The aircraft landed at about 80 kts.

He was about to apply wheel brakes when he saw an electrical cattle wire in his peripheral vision. He pulled back on the yoke. The aircraft became airborne again, but the wire caught the main wheels, and nicked the propeller at the rear of the aircraft. The aircraft came to rest a further 100 feet from this wire. The total landing run was in the region of 600 ft. Both pilot and passenger exited the aircraft normaly and no injuries were reported.

Prior to the aircrafts removal from the field the engine was re-started and ran satisfactorily.

1.2 Damage to the aircraft

There was no apparent structural damage to the aircraft with only slight abrasions to the paintwork. There was minor non-structural damage to the underside of the airframe, the top and bottom surfaces of both wings and the undercarriage fairings The propeller was also damaged by the electric wire fence.

1.3 Aircraft Information

The Long-EZ is one of a line of canard designs produced by Burt Rutan, and is derived from the Vari-EZ, which was offered to home-builders from 1976. The larger Long-EZ was tested on 12 June 1979. The aircraft is intended for efficient long-range flight, and can travel for over ten hours and up to 1,600 miles on 52 gallons of fuel. The pilot sits in a semi-reclined seat, controlling the Long-EZ with a side stick controller on the right console. As well as having an airbrake on the underside, the wing-tip rudders can be deflected outwards to assist the brake. If the aircraft reaches too low a speed, the front (canard) wing will stall and lower the nose until speed is regained. The nose undercarriage is extended by the pilot on entering the aircraft and can be retracted once airborne.

In Ireland, the building and testing of home-built aircraft is regulated by the Society of Amateur Aircraft Constructors (SAAC). These aircraft are not issued with a Certificate of Airworthiness but with a Permit to Fly. EI-CMR was first registered on 2 May 1996 and had a Flight Permit issued by the IAA on 27 March 2003. Between that time and the time of the incident the aircraft had flown 5 times in as many hours.

Primary Function:	Two-Seat Homebuilt Sporting Aircraft
Manufacturer:	Rutan Aircraft Company Mojave, California
Accommodations:	Two
Wingspan:	26 feet 3.5 inches
Wing Area (Gross):	94.1 square feet
Empty Basic Weight:	710-lbs
Empty Equipped Weight:	750-lbs
Maximum T/O Weight:	1,325-lbs
Internal Fuel:	52-US gal
Maximum Cruising Speed:	185-mph at 75% power at 8,000 feet (solo) 183-mph (two-seat)
Cruising Speed:	144-mph at 40% power at 12,000 feet
Service Ceiling:	27,000 feet (solo) 22,000 feet (two-seat)
Climb Rate:	1,750 fpm (solo) 1,350 fpm (two-seat)
T/O Run:	550 feet (solo) 830 feet (two-seat)
Landing Run:	450 feet (solo) 680 feet (two-seat)
Range:	1,370 miles with max fuel at max cruising speed, 40 min reserves (solo) 965 miles (two-seat) 2,010 miles with max fuel at 40% power, 40 min reserves (solo) 1,430 miles (two-seat)

1.4 Pilots comments

The pilot stated that because he was descending over the open sea to approximately 300 feet and then climbing again over land, the carburettor heat was being used frequently. In the aftermath of the original rough running he placed the Carb heat on for around one full minute when flying straight and level. When climbing up and then experiencing the engine failure he only briefly checked the Carb heat, thinking that it was some type of fuel starvation. However, afterwards, on reflection, he was of the opinion that the Carb heat was not fully clearing the icing.

1.5 Meteorological information

Met Eireann supplied the following weather information to the Investigation:

General Situation:	A low-pressure system in mid Atlantic maintained a moist southerly airflow over the area. A frontal system off the southwest coast was approaching the area slowly.
Wind:	At surface: 16012KT At 2000 ft. 18022KT
Weather:	Radar imagery suggested the possibility of light rain in the vicinity.
Visibility:	10+ kilometres
Cloud:	FEW 2200FT SCT 3500FT BKN 5000FT
Surface Temperature Dew-Point:	15/12° Celsius
MSL Pressure:	1013 hPa
Comment:	Around the time of the incident the relevant temperature and dewpoint were approximately 13° Celsius and 10° Celsius respectively. This could have led to serious icing at any power setting assuming no carburettor heating was being implemented.*(ie. selected)*

1.6 Inspection of aircraft

A SAAC inspector later inspected the aircraft at Waterford Airport. He paid particular attention to the fuel system. The carburettor fuel screen and the gascolator filter were removed and examined. He also took a fuel sample from the carburettor and the fuel tanks. No contaminants or Foreign Object Damage (FOD) in the fuel or the filters were found. He ran up the engine in accordance with the Lycoming Operators' Manual and the engine ran normally and was within all prescribed limits. He inspected the undercarriage and found no damage to the attachment points. There were minor wire-strike marks on the fairings but, otherwise, the undercarriage was undamaged. There were no defects found and the inspector considered the aircraft and it's engine fit for service pending the repair of the above damage. He made the appropriate entries in the logbooks and on 28 August 2003, signed out the aircraft as fit for service.

1.7 Engine Icing

Carburettor icing is prevented by heating the intake air by utilising hot exhaust gases in a heat exchanger. Carburettor icing can occur on relatively warm days particularly if conditions are sufficiently humid. This type of icing is more likely at a low power setting such as that used during descent on the approach to a landing. This is because there is a greater temperature drop at the carburettor venturi and the nearly closed butterfly valve can be more easily restricted by the ice build up.

The "HOT" position should be selected in time to prevent the formation of ice, because if the selection is delayed the use of hot air might be too late to melt the ice before the engine stops. A slight drop in RPM would be the first sign of carburettor icing and this may not be associated with any rough running of the engine. Partial heating can induce carburettor icing as it may melt ice particles, which would otherwise pass into the engine without causing trouble, but not prevent the resultant mixture from freezing as it passes through the induction system. Alternatively, partial heat may raise the temperature of the air into the critical range.

The chart at **Appendix A** shows the wide range of ambient conditions conducive to the formation of induction system icing for a typical light aircraft piston engine. This chart is reproduced from the General Aviation Safety Sense Leaflet 14A which is a UK CAA publication. It is also issued in similar form in Aeronautical Information Circular NR 11/97, published by the IAA. Both are based on research carried out by the National Research Council of Canada (NRCC). Flight tests have produced serious icing at descent power with the ambient temperature above 30° C even with a relative humidity as low as 30%.

Since 1983 three accidents are recorded by the NTSB involving Long-EZ aircraft, having similar Lycoming O-235 engines, where weather conditions were favourable for the formation of carburettor ice.

1.8 Aircraft Designer's Comment

Rutan said that with over 8,000 flight hours in their aircraft they had seldom seen problems caused by carb ice in Long-EZs particularly with Lycoming engines installed. However they state that anything that can be done to help avoid carb ice accumulation should be done. The aircraft flight manual states: *"Icing can occur during cruise in moist air, particularly at low cruise power settings. When in moist conditions, check carburettor heat often or cruise with heat on."*

1.9 Experimental and Homebuilt Aircraft

The US Aviation Consumer magazine states that experimental homebuilt aircraft have an accident record that is worse than that experienced with certificated, factory-built types. This is due to a number of factors. There are more chances for non-conformality to occur, thus each airplane built is actually a new, experimental, research, high-risk article. In addition the aircraft, as in this case, is often tested by pilots who have very little time on type.

In the case of EI-CMR the words "Experimental Aircraft" are displayed on the inside of the front cockpit canopy. The UK CAA directs that aircraft having a Permit to Fly should be *"placarded showing aircraft operating limitations and conditions"*.

A group flying this particular aircraft in California also recommend placarding the cockpit and flight manual so that those who ride in them as passengers are aware of the higher risks involved. The requirements for flying home-built aircraft in Ireland are described in the IAA Aeronautical Notice A19.

1.10 Test Flight

A test flight for the renewal of the Permit-to-Fly took place on 27 August 2004. This was the first flight following the incident and the aircraft was flown by a UK qualified instructor. The aircraft owner was on board to "record figures and to bring the aircraft up to gross weight". The weather was fair with a light NW wind and a good spread between Temperature and Dew point. RWY 03 at Waterford was in use for this flight.

After completing the test items the aircraft was some 5 or 6 miles NW of Waterford and just above 3,000 ft when the engine ran down and stopped. An emergency was declared and a return to Waterford commenced. Attempts to restart the engine failed and a landing was made on RWY 21.

There was no apparent mechanical problem and the engine started easily about half an hour later. The cause of the failure was unclear. Carburetion and/or ignition were the main suspects. Reports indicate that the spark plug electrodes had been prone to exhibit a black deposit following engine run. The magnetos and the carburettor were sent for overhaul. After the event, the fuel system and its vents were checked and found to be clear.

1.11 Contractor Report

A report from the contractors following overhaul stated that the carburettor had been running rich and that the magnetos were found "weak". On disassembly, it was evident that both magnetos were in poor condition and in need of overhaul. They had the old style coils which may possibly have been breaking down due to heat degradation and may have been the cause of the above engine problems. One magneto had the old style impulse fitted and both had the old distributor gears which should have been replaced previously. The contacts had not been changed and the brushes were badly worn.

The manufacturers state that their magnetos should be overhauled every four years and inspected every 500 flight hours. As it was, the previous overhaul took place seven years previously with only a few hours flown since then.

The returned carburettor and magnetos were later installed on the engine and the engine ground run satisfactorily.

1.12 Component Histories

No details of magneto hours run were available to the contractors but it was reported to the Investigation that the engine of this aircraft had been installed in an SE5 WW1 replica aircraft used in the making of the film "The Blue Max" in the late 1960's. The engine, with a total of 265 hours in service was stripped down in July 1998. On re-assembly, a Certification was issued stating that, Modification/Replacement/Inspection of the engine had been carried out "*in accordance with prescribed statutory Air Worthiness Requirements*".

2. ANALYSIS

The forecast and aftercast figures for temperature and dew point at the time of the accident in June 2003 indicate that there was a risk of serious icing at any power.

This aircraft has a very efficient aerodynamic shape due to its low drag characteristics. If the aircraft is descending or in a low glide situation the engine may be operating at 1600/1700 RPM with the throttle towards the closed position. If conducive weather conditions are present then induction icing can quickly take place. Under the conditions prevailing on the day serious icing could take place even at climb power. Even though the pilot was using Carb heat at intervals during the flight this may have been insufficient to melt any ice formed. This would have been particularly so if the engine had been idled for long periods during the flight. Also with the engine idling there would have been less heat available to heat the air in the heat exchanger prior to entering the carburettor.

The aircraft had traversed the sea several times and this would have increased the humidity of the air entering the engine. However, when dewpoint information is not available good airmanship would dictate that the pilot should always assume conditions of high humidity. The pilot should select full heat whenever carb heat is applied. Partial hot air should only be used if an intake temperature gauge is fitted and/or in accordance with the Flight Manual.

If carburettor icing has taken place, it may take up to 15 seconds for the ice to clear. This may seem a very long time if the aircraft is 300 to 600 ft AMSL and the pilot is looking for a suitable field on which to land.

The pilot had a total of 7 hours on type. A Dutch visitor, engaged in taking photographs, was a passenger in the rear cockpit. Passengers should be aware of the higher risks involved in flying in a homebuilt aircraft rather than a factory aircraft with a full Certificate of Airworthiness. A placard to this effect placed in both cockpits should be considered for all homebuilts.

It is not known whether engine failure in flight on the incident occasion was due to carburettor icing, over-rich setting of the carburettor leading to incorrect fuel/air ratio or degradation of the magnetos due to overheating. On the subsequent test flight care was taken to avoid weather conditions conducive to carburettor icing. A black deposit on the plugs would indicate an incorrect setting or malfunction of the carburettor which was not detected on the ground during engine run-up. The importance of having routine servicing of components conducted at the proper times and the traceability of components is evident from the above incident and the subsequent test flight.

3. CONCLUSIONS

(a) Findings

1. The engine stopped in flight necessitating a forced landing in a field on 28 June 2003 and again on a runway on the next and subsequent test flight on 27 August 2004.

2. Because of its clean aerodynamic characteristics, this aircraft is capable of maintaining flight using low engine power settings. The operation of the engine at such settings in high relative humidity is conducive to carburettor icing.

(b) Causes

The setting of the carburettor mixture control leading to a rich fuel/air ratio combined with degradation of the magneto performance in flight. On the day of the original incident, weather conditions of temperature and dewpoint were also such as to lead to serious carburettor icing at all stages of flight. This would have compounded the problem.

4. SAFETY RECOMMENDATIONS

4.1 The owner should install a carburettor temperature gauge in this aircraft**.** **(SR 21 of 2005)**

4.2 The IAA should consider an addition to Aeronautical Notice A19 to include the requirement to placard the cockpits with a warning that homebuilt aircraft have a lesser inherent airworthiness standard than certificated manufactured types**.** **(SR 22 of 2005)**

The IAA responded to this Recommendation and stated that "Flight Permits now include this and all current Permits have this requirement included."

The aircraft, with its nose undercarriage retracted, following its forced landing in a field at Bunmahon, Co.Waterford.

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APPENDIX A