ACCIDENT

Aircraft Type and Registration:	DA 42 Twin Star, G-SUEA
No & Type of Engines:	2 Thielert TAE 125-02-99 piston engines
Year of Manufacture:	2007
Date & Time (UTC):	20 January 2009 at 1457 hrs
Location:	Lands End Aerodrome, Cornwall
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 2
Injuries:	Crew - 1 (Minor) Passengers - 2 (Minor)
Nature of Damage:	Substantial damage to forward fueslage and propellers
Commander's Licence:	Private Pilot's Licence
Commander's Age:	47 years
Commander's Flying Experience:	1,315 hours (of which 62 were on type) Last 90 days - 38 hours Last 28 days - 10 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft overturned on soft ground beyond the airfield boundary following a rejected takeoff. The takeoff distance available was less than that required by the aircraft under the prevailing conditions to become safely airborne.

History of the flight

Prior to departure from Stapleford, the pilot telephoned the ATC tower at Lands End and was advised against attempting the trip due to poor weather. However, the pilot took off and was able to avoid the bad weather using the aircraft's weather mapping system. By the time G-SUEA arrived at Lands End the storms had passed and the weather had improved. The aircraft landed on Runway 25. The pilot noted that the airfield's grass surface was very wet, particularly around the hard standing areas beneath the ATC tower where he was instructed to park.

When the pilot returned to the aircraft, he carried out his normal pre-flight checks. He noted that the left engine oil quantity was low and added approximately one quart of oil. He reported that the engines started without difficulty and carried out the normal power checks, without problems.

When the pilot began to taxi onto the grass area from the hardstanding, the aircraft became bogged down in the soft ground. He shut down the engines and an Airport Fire Services (AFS) vehicle towed the aircraft back onto

the area of hardstanding. They also washed the landing gear which had become contaminated with mud during the pilot's initial attempts to extricate the aircraft from the soft ground with the use of full power.

Having by now performed several engine starts, the pilot was aware of a L ECU A FAIL caption illuminating on the Primary Flight Display, indicating a failure in the left engine control system. He reported that the warning was not always present on engine start-up and he therefore decided to continue with his preparations for the flight.

The pilot then taxied the aircraft across the airfield to line up on Runway 25. From the wheel tracks on the runway, the position of the aircraft at the start of this takeoff roll would have given a runway distance remaining of 465 m. As engine power was increased to begin the takeoff roll, the aircraft immediately became bogged down again, so the pilot shut down the engines.

The AFS then towed the aircraft to the right side of Runway 25, adjacent to the normal threshold, Figure 1. The pilot reported that he thought his location was closer to the airport buildings and on the left side of Runway 25. He then attempted to take off. His plan was to track alongside Runway 25, displaced to the left, which he felt was firmer ground than on the runway itself. As power was increased, the aircraft accelerated. The pilot was closely monitoring the airspeed, hoping to reach 70 kt in order to be able to lift off. However, at around 46 kt he reported a "pull to the left" and became aware of the L ECU A FAIL caption being illuminated. He then retarded the throttles and aborted the takeoff.

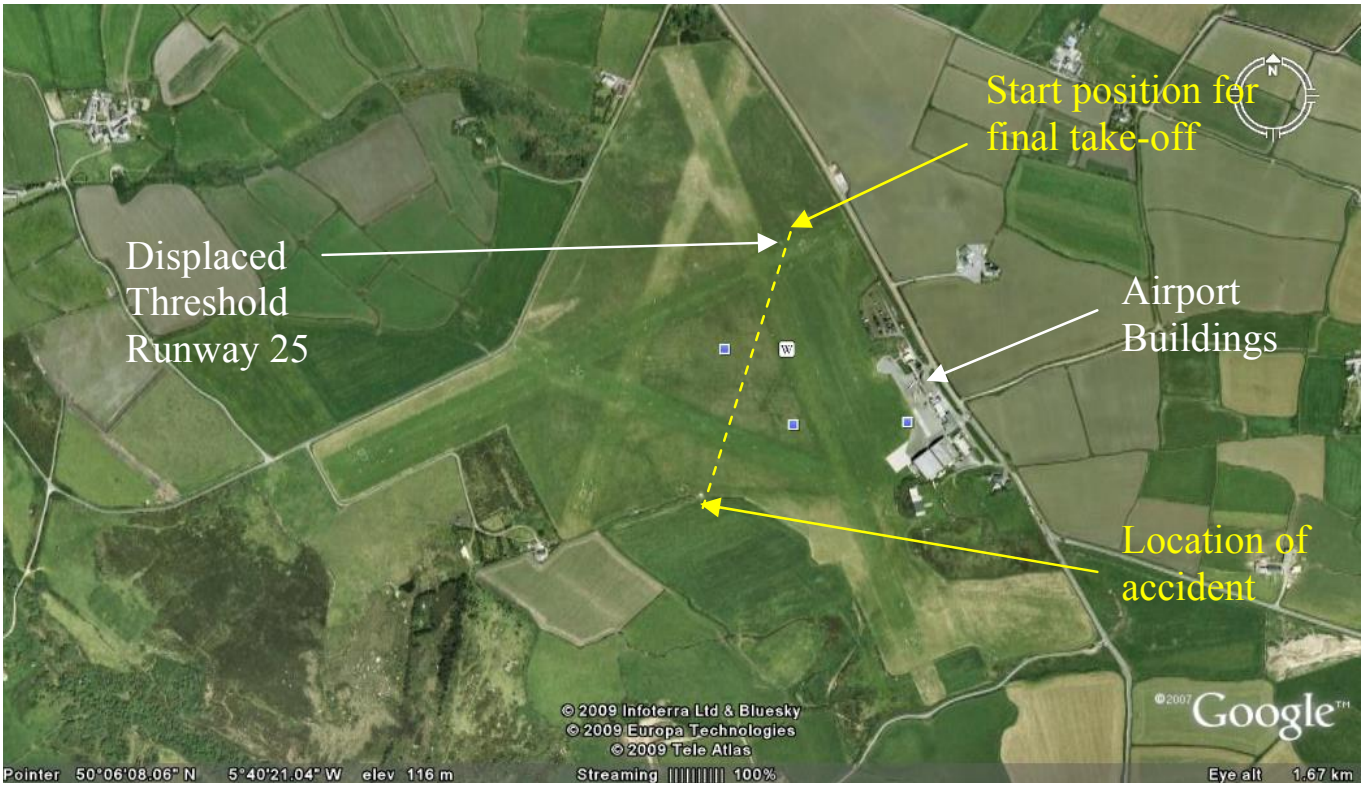

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Figure 1

Lands End Airfield

The wheel marks on the airfield indicated that the aircraft had followed a straight track in a direction of approximately 200° from its start location on the right side of Runway 25. It had covered approximately 350 m when it crossed the airfield boundary and entered a ploughed field. The aircraft immediately nosed over in the very soft ground, coming to rest inverted.

The AFS attended and the pilot and both passengers, who all suffered minor injuries, were assisted in escaping from the aircraft. There was no fire.

A special meteorological observation taken just after the accident gave the surface wind as 250/14 kt, unlimited visibility, clouds FEW012 and FEW016CB, with a temperature of +5ºC.

Engine description

The DA 42 is fitted with two Thielert TAE 125-02-99 liquid-cooled, four-cylinder, four-stroke, turbocharged common-rail direct injection diesel engines, designed to run on Jet A-1 fuel. Each engine is rated (takeoff power) at 99 kW (135 DIN HP) at 2,300 rpm at sea level ISA conditions, and drives a three-bladed, variable-pitch, wood-composite propeller via a 1:1.69 reduction gearbox. The maximum allowable continuous propeller speed is 2,300 rpm, corresponding to an engine speed of 3,900 rpm. The engine and propeller are controlled by a dual channel, digital Engine Control Unit (ECU).

The ECU electronically controls the manifold pressure, fuel rail pressure (which determines the quantity of fuel injected) and propeller speed, according to the power lever position. The engine is normally controlled and regulated by Channel A. However, if a failure is detected, Channel B will automatically take over control. Also, the ECU records fault information in an 'event log' and time history information at one second intervals for various engine parameters.

Engine parameters, including propeller speed and engine load (as a percentage derived from the manifold pressure) are displayed on a central Multi Function Display (MFD) in the cockpit. The Primary Flight Display (PFD) displays the crew alerting (annunciator) system, in addition to air data, attitude, and heading information. A warning or caution annunciator will flash on the PFD, accompanied by an aural tone. A warning is accompanied by a repeating tone and a caution is accompanied by a single tone.

In case of minor faults, the annunciation can be reset once by pressing the ECU TEST button for more than 2 seconds. However, the annunciation will re-appear upon the next attempt to start the engine.

Engine examination

A download was performed to extract the fault information and time history data from both ECUs. The data was supplied to the engine manufacturer for assistance in interpreting the information.

There were no faults recorded by the right engine ECU. The data from the left ECU indicated that the engine was shut down at 1119 hrs with Channel A active and no faults recorded. The first warnings were recorded at around 1202 hrs when oil temperature (TOIL), coolant temperature (TH2O), outside air temperature (TAIR), oil pressure (POIL), fuel rail pressure (PRAIL) and gearbox temperature (TGEAR) sensor failures were detected. These sensor faults would have resulted in a flashing L ECU A caution. The engine was started at 1357 hrs and since the 'health' of Channel A was lower than that of Channel B, control of the engine automatically passed to Channel B.

AT 1358 hrs the engine was re-started with Channel B in control. The ECU test button was reset, which should have resulted in the flashing L ECU A FAIL caution becoming steady. There were various resets and engine restarts, all of which would have resulted in a steady L ECU A caution.

At 1450 hrs the final takeoff attempt began with left engine ECU Channel B in control; a steady L ECU A caution would have been illuminated.

The data shows an increase of engine power on both engines to maximum for 28 seconds, before the power decreased and both engine speeds reduce to zero. Both ECUs continued to record information until the battery became depleted.

Flight Manual Abnormal Operating Procedures

The Flight Manual Abnormal Operating Procedures following an ECU fail caption states:

> ***'L/R ECU A FAIL***
>
> *(a) 'ECU A' caution on ground*
>
> - *Terminate flight preparation*
>
> *(b) 'ECU A' caution during flight*
>
> ***NOTE***
>
> *In case of a failure on the electronic ECU (Engine Control Unit) 'A' the system automatically switches to ECU 'B'*
>
> *1. Press the ECU TEST button for more than 2 seconds to reset the caution message*
>
> *if ECU A caution message reappears, or cannot be reset;*
>
> *2. Land on the nearest suitable airfield.*
>
> *3. The Engine must be serviced after landing*
>
> *if ECU A caution message can be reset;*
>
> *2. Continue flight.*
>
> *3. The Engine must be serviced after landing'*

Airfield information

There are four grass runways at Lands End Airfield; Runway 25 has a declared Take Off Run Available (TORA) of 695 m and this allows for a displaced threshold due to the proximity of vehicles on an adjacent road. It slopes downhill by 32 m along its length, giving a gradient of 4.6%. The UK AIP states that:

> *'both Runways 16/34 and 07/25 are sufficiently wide to allow differential use of each side of the runway in order to conserve the grass surfaces.'*

The UK AIP also states:

> *'some parts of the manoeuvring areas are undulating.'*

A NOTAM was issued from Lands End at 1000 hrs UTC on the day of the accident which further displaced the threshold of Runway 25 due to soft ground; the TORA was reduced to 574 m.

The ground actually traversed by G-SUEA was from the threshold of Runway 25 to its final position beyond the airfield boundary, between the thresholds of Runways 02 and 34. The elevation at the accident location was approximately 384 m, giving a very slight downslope from the threshold elevation of 389 m of Runway 25.

Aircraft performance

The Aircraft Flight Manual (AFM) contains aircraft performance information and also states:

> ***'WARNING***
>
> *For a safe takeoff the available runway length must be at least equal to the takeoff distance over a 50 ft (15m) obstacle.*
>
> ***CAUTION***
>
> *The figures in the following NOTE are typical values. On wet ground or wet soft grass covered runways the takeoff roll may become significantly longer than stated below. In any case the pilot must allow for the condition of the runway to ensure a safe takeoff.*
>
> ***NOTE***
>
> *For takeoff from dry, short-cut grass covered runways, the following corrections must be taken into account, compare to paved runways (typical values, see CAUTION above)*
>
> - *grass up to 5cm (2 in) long: 10% increase in takeoff roll*
> - *grass 5-10cm (2 to 4 in) long: 15% increase in takeoff roll*
> - *grass longer than 10cm (4 in): 25% increase in takeoff roll*
> - *on grass longer than 25cm (10 in): takeoff should not be attempted.'*

The data supplied in the Aircraft Flight Manual (AFM) is unfactored. CAA Safety Sense Leaflet (SSL)7c, '*Aeroplane Performance'*, states:

> *'It is strongly recommended that the appropriate Public Transport factor, or one corresponding to that requirement, should be applied for all flights. For take-off this factor is x 1.33 and applies to all single-engined aeroplanes and to multi-engined aeroplanes with limited performance scheduling (Group E). This factor allows for lack of practice, incorrect speeds/techniques, aeroplane and engine wear and tear, and less than favourable conditions.'*

The leaflet also details further factors which should be applied in certain circumstances. For example, on firm dry grass runways an increase of 20% should be applied to the takeoff distance and, on soft ground, this rises to 25%. These factors are cumulative and the overall factor of 1.33 should then be applied. Given the weight of the aircraft and its occupants, temperature conditions and approximate fuel load of ⅔ of the maximum, the takeoff distance indicated by the AFM is 490 m. This increases to 588 m when taking off from a firm dry grass surface, 735 m from soft ground, rising to 977 m when the overall 1.33 factor is applied.

SSL7c also warns:

> *'grass, soft ground or snow increase rolling resistance and therefore the take-off ground run. When the ground is soft, a heavy aircraft may 'dig in' and never reach take-off speed.'*

Analysis

Having experienced a number of left engine ECU A fault indications during start-up, the AFM advises that an operator should *'Terminate flight preparation'*. Therefore, it would have been advisable for the pilot to have sought assistance before continuing with his preparations for flight.

The multiple sensor failure indications were associated with sensors which supply information to both channels of the left ECU. However, only Channel A recorded failures, and these were intermittent. It is therefore unlikely that these failures logged by the ECU were due to faults with the sensors or their wiring.

Despite the left engine ECU A warning, the recorded information indicated that both engines developed full power during the last attempted takeoff. The distance travelled from the aircraft's start position, beside Runway 25, to the accident location, was around 350 m and this was insufficient distance for the aircraft to have become airborne.

The pilot's decision to continue with the takeoff, off runway and despite the outcome of the first attempt, was ill-advised. CAA Safety Sense Leaflet 23 – *'Pilot's its Your Decision'* discusses issues surrounding the decision making process with regard to flying. In his report, the pilot stated that it was the wrong decision to attempt a takeoff at all and concluded that he would not be operating a DA-42 from a wet grass surface again.