Accident to the DIAMOND DA62 registered D-IRAY on Thursday 21 September 2023 at Seichamps

Time	Around 10:50[1]
Operator	Private
Type of flight	Cross country
Persons on board	Pilot and one passenger
Consequences and damage	Pilot and passenger injured, aeroplane destroyed
This is a courtesy translation by the BEA of the Final Report on the Safety Investigation. As accurate as the translation may be, the original text in French is the work of reference.	

Engine failure in climb, emergency landing, collision with vegetation

1 HISTORY OF THE FLIGHT

Note: the following information is principally based on the engine computers (EECU), statements, radiocommunication recordings and radar data.

The pilot and his passenger were carrying out a cross-country flight in France over a few days, with several legs planned. The day before the occurrence, they started their return journey on taking off from Béziers - Vias airport. They landed at Nancy - Essey at the end of the morning and decided to stop there for the night. The pilot refuelled with 200 litres of fuel.

The morning of the occurrence, the pilot and his passenger got ready to take off under an IFR flight plan bound for Bonn-Hangelar (Germany). Runway 21 was in use, the wind was from 170° of 10 kt.

The pilot asked for clearance to start up and then taxied to holding point Bravo. He waited there for a few minutes for his flight plan to be accepted. The pilot would indicate that he programmed his flight in the avionics suite and carried out the engine computer checks. He would add that he carried out the before take-off checklist up to the line up procedure. He opted for a take-off with flaps retracted.

Once the flight plan was confirmed, and in contact with the AFIS[2] officer, he backtracked runway 21 and took off.

[1] Except where otherwise indicated, the times in this report are in local time. Two hours should be subtracted to obtain universal time coordinated (UTC).
[2] The glossary of abbreviations and acronyms frequently used by the BEA can be found on its web site.

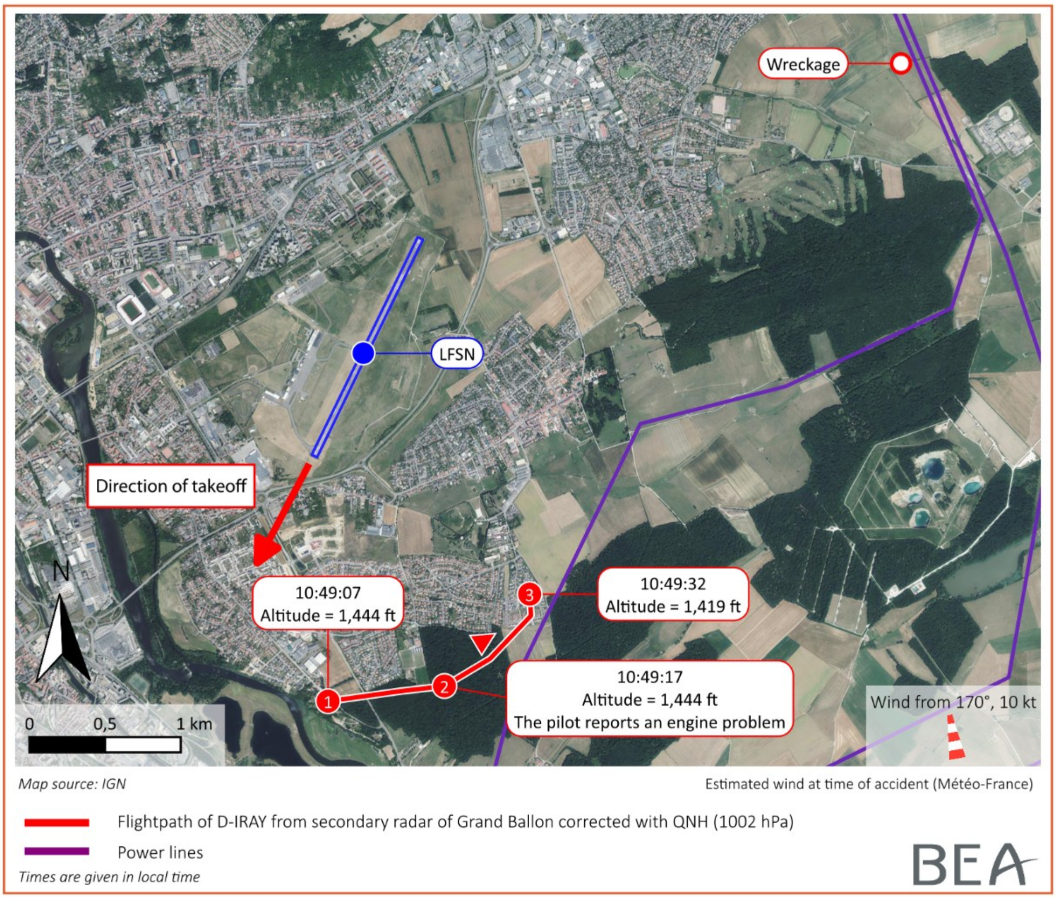

Figure 1: flight path of DA62 registered D-IRAY

While in climb, at an altitude of around 1,400 ft (i.e. a height of around 700 ft) and in a left-hand (LH) turn, the pilot reported on the AFIS frequency that he was "*Coming back to field having engine problem*" (see **Figure 1,** point 2).

Thirty seconds later, he indicated "*Having single engine*". Less than a minute later, the pilot of a DR400 lined up on runway 21, reported on the frequency that he could see the aeroplane in descent.

The pilot carried out an emergency landing in a field (at 2 NM from the threshold of runway 21), the aeroplane collided with a hedge and came to a stop a few metres further on.

The pilot and his passenger evacuated the aeroplane.

2 ADDITIONAL INFORMATION

2.1 Pilot information

At the time of the accident, the 58-year-old pilot held a commercial pilot licence (CPL(A)) obtained in 2015 along with a multi-engine piston (MEP) rating and an instrument (IR) rating. He had logged approximately 1,140 flight hours including 775 hours on twin-engine aeroplanes. He had notably flown 500 h on the DA62, including 40 h in the previous three months.

2.2 Meteorological information

The day of the occurrence, the temperature at Nancy was 21°C. The Nancy - Essey weather station reports indicated:

- at 08:30 UTC (i.e. 10:30 local time), a mean wind of 8 kt from 170°, visibility greater than 10 km, few clouds at a height of 4,500 ft and scattered clouds at a height of 5,500 ft;
- at 09:00 UTC (i.e. 11:00 local time), a mean wind of 8 kt from 180°, visibility greater than 10 km, few clouds at a height of 5,300 ft and scattered clouds at a height of 7,480 ft.

2.3 Aerodrome information

Nancy - Essey airport has a paved runway oriented 03/21 measuring 1,600 m long.

To take off under IFR from runway 21, the departure procedure is omnidirectional: "*Climb straight ahead to 2 000', then depart directly climbing to MEA. Minimum climb gradient 4,4% due to obstacle 1 631', 4.3 NM from DER, 1.0 NM right of axis and mast 1 929', 1.8 NM/330° from ARP.*"

Although carrying out an IFR departure, the pilot did not adopt this flight path and turned left in the runway circuit at 1,400 ft.

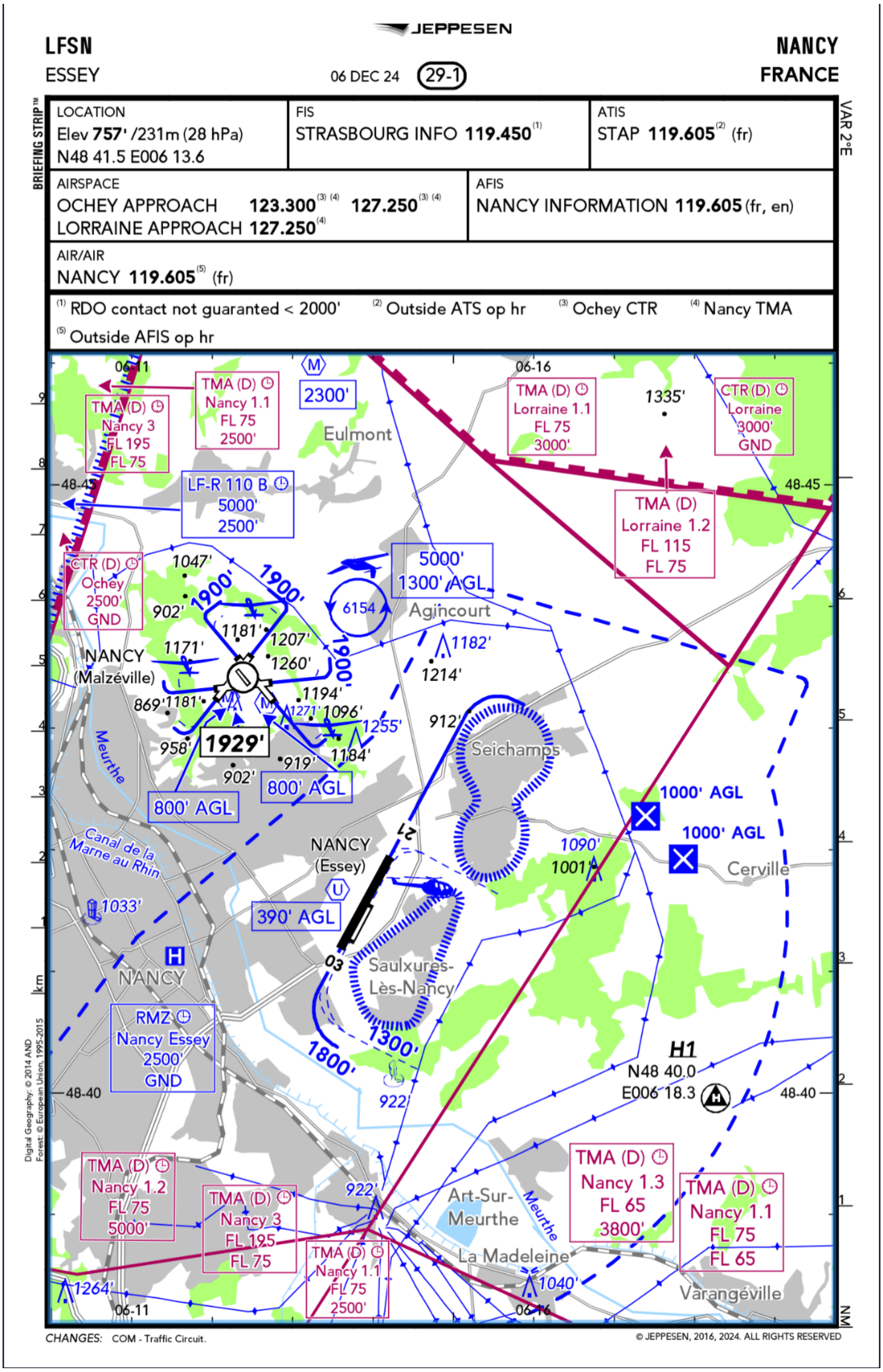

Figure 2: LFSN VFR approach chart (source: Jeppesen)

The pilot used the Foreflight application, he did not specify what chart he used. For illustration, the VFR approach chart (see **Figure 2**) shows the surrounding terrain and the obstacles (including power lines).

2.4 Aircraft information

The DA62 is a low-wing, twin-engine aeroplane with a retractable landing gear. It is equipped with E4P-C piston diesel engines manufactured by Austro Engine.
It is also equipped with MTV-6-R-C-F/CF194-80 propellers.

D-IRAY belonged to the pilot's company which had purchased it new in 2017, its year of manufacture. The aeroplane had logged 500 flight hours at the date of the accident.

The aeroplane was equipped with a Glass Cockpit Garmin G1000 avionics suite composed of a PFD (Primary Flight Display) and a MFD (Multi-Function Display). Each unit has two slots for the SD card which stores the map and terrain databases and records flight data.

The DA62 is certified to hold a rate of climb with one engine inoperative at the altitudes encountered, within the limits of the maximum permissible weight.

The day of the occurrence, the estimated take-off weight was 2,123 kg for a maximum take-off weight of 2,300 kg. The aeroplane was within its weight and balance envelope.

The rate of climb for the conditions of the day (temperature 21°C, altitude 2,000 ft, weight 2,100 kg, clean configuration) was 220 ft/min with one engine inoperative, i.e. a gradient of 2.4%. This rate of climb supposes that the operative engine is providing 95% of its power and that the inoperative engine has been feathered. The speed to be adopted is 89 kt.

On the DA62, a propeller is feathered by setting the Engine master switch to OFF. If the engine power is decreased using the power lever, the propeller speed will be adjusted according to the Propeller Setpoint Curve (see **Figure 3**). If the power lever is pulled back to 0%, the propeller speed will be adjusted to 2,100 rpm. The setpoint will attempt to hold around 2,100 rpm all the time the airspeed is sufficient to maintain that speed.

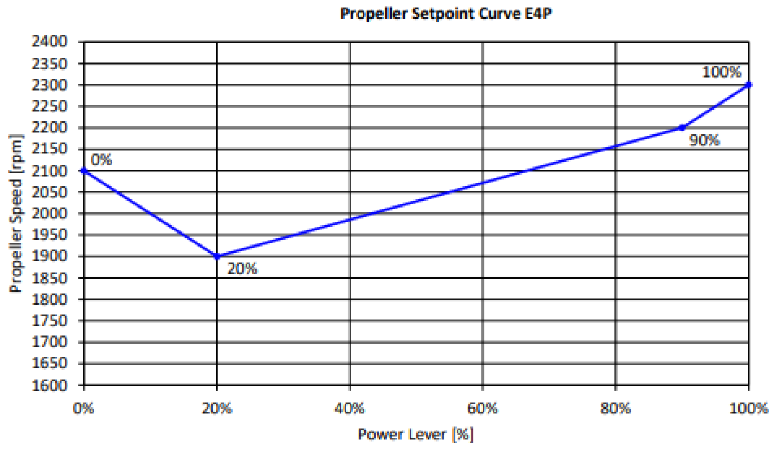

Figure 3: speed of propeller according to engine power (source: Diamond Aircraft)

2.5 Site and wreckage information

The accident site was situated to the north-east of Nancy - Essey airport, at around 2 NM from the threshold of runway 21. The examination of the site found that the aeroplane's LH wing had separated from the airframe on coming into contact with a hedge. The main wreckage of the aeroplane was found at around 30 m from this impact zone.

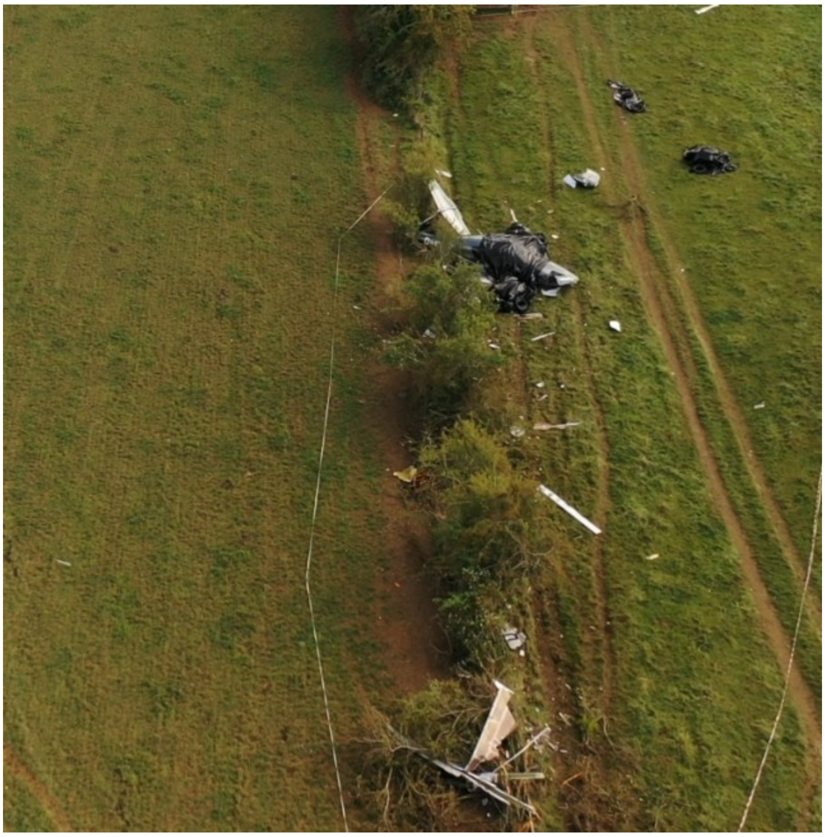

Figure 4: photo of accident site (source: BEA)

The cockpit was in good condition. The following points were observed:

- one of the engine control switches had been moved by the emergency services. The emergency services could no longer remember which one;
- the two LH and RH (right-hand) fuel pumps were set to ON;
- the yaw trim was centred and slightly to the right;
- the flap control was in the "Take-off" position;
- the elevator trim was in the "Nose-up" position;
- no SD card was present in the slots of the avionics suite[3].

[3] The pilot indicated that the SD cards were normally present. It seems unlikely that they were ejected during the impact.

Figure 5: view of cockpit (source: BEA)

2.6 Pilot's statement

Note: the BEA did not immediately speak with the pilot. Only a written statement (in German) was sent to the BEA by the pilot some time after the occurrence. The main elements of this statement are included in the history of the flight and are given below.

The pilot explained that their departure was initially planned for 10:30 but that it had been pushed back by ten minutes due to an update to the flight plan.

The pilot indicated that after starting up the engines, he programmed his flight plan in the avionics suite while the engines continued to run at around 10%. He carried out the EECU checks and the "Before T/O C/L" up to the line up procedure.

He indicated that during the climb, he turned left in the runway circuit. He explained that he saw the red R GBOX TEMP light (warning indicating a high temperature in the RH engine gearbox) and the associated temperature in the red range shortly before coming out of the turn. He indicated that he transmitted a radio message advising that he had an engine problem and that he was returning to the airport. He added that he performed the L/R GBOX TEMP procedure from memory and reduced power on the RH engine to cool the gearbox.

He indicated that he took a quick look at the runway and surrounding terrain and reviewed all possible options with one engine inoperative.

He considered that a RH turn was not possible due to the hill on the right. An extended turn over an inhabited area on an uphill slope before runway 21 would, in his opinion, have been too risky, and he considered he was too low. He also considered that the option of continuing straight-ahead with a minimal rate of climb over an uphill slope and power poles at the end of the runway circuit was not feasible. He explained that landing on the reciprocal-QFU was also not possible.

He added that he decided to continue the flight in order to carry out a precautionary landing in a field, should the gearbox temperature not decrease and he had to shut down the RH engine and feather the propeller.

He indicated that he took the checklist and reviewed the L/R GBOX TEMP emergency procedure. He checked the associated temperature indication and observed that there was no drop in temperature.

He explained that he shut down the RH engine so that the propeller would feather, the temperature of the gearbox would not rise and to give him a manoeuvring margin with the LH engine for landing.

He added that he decided to continue straight ahead toward a field with an uphill slope, with sufficient space before the power line. He then extended the landing gear, and, due to gusts of wind, preferred not to extend the flaps to avoid further reducing the approach speed.

He explained that shortly before touchdown, he was surprised by a gust of wind from behind. The RH wing slightly banked. He then applied full power to the LH engine, pressed the LH rudder pedal, and the wing returned to a horizontal position.

He indicated that the roll to the RH side and the full power delivered by the LH engine changed the direction of flight to the right, towards a hedge of bushes. He then pulled on the stick to clear the bushes and land the aeroplane.

He added that the aeroplane touched down hard and that he and his passenger were able to exit the aircraft without difficulty.

2.7 EECU engine parameters

The engines are equipped with EECU that continuously record the engine parameters. The engine manufacturer, Austro Engine downloaded and examined the EECU data.

The engines were started up at 10:36. Between engine start-up and increasing power for the take-off run, there was no brief increase in engine power to 97%, which would correspond to the execution of the "*Available power check*," the last item on the "Before T/O C/L." According to the manufacturer, this item ensures that the engines are capable of delivering full power before the take-off run.

The following graph shows the parameters for the last four minutes of the flight.

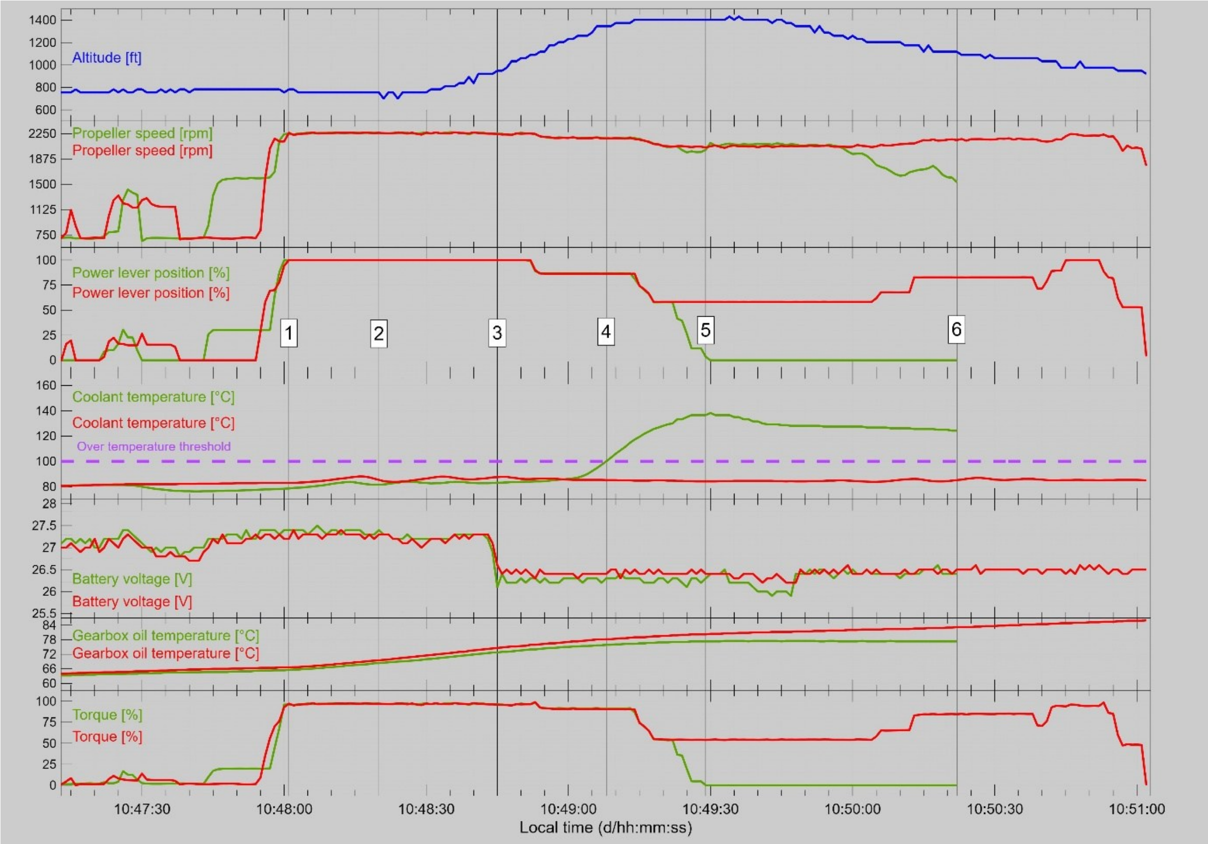

Figure 6: data from the EECU for the last four recorded minutes
In red: LH engine, in green: RH engine

The main events are the following:

Engine power was increased at 10:48 (see **Figure 6**, point 1) and the aeroplane took off 20 s later (point 2). Around thirty seconds after taking off, when the power levers were set to 100%, the battery voltages of the LH and RH engines went from 27.2 V to 26.5 V and 26.1 V respectively (point 3). Twenty seconds later, the temperature of the coolant in the RH engine started to increase in an abnormal manner. The power levers were moved back to 90% during the climb.

In a ten-second period, the temperature of the coolant in the RH engine exceeded 100°C, the limit which activates the R ENG TEMP warning (point 4).

The levers of both engines were pulled back to 58%. Ten seconds later, the RH engine lever was progressively pulled back to 0%.

The maximum temperature of the coolant in the RH engine was 138° (point 5).

While the engine power was at 0%, the rotation speed of the RH engine propeller remained unchanged for 28 s, then the rotation speed decreased.

Note: the setpoint held the propeller speed at approximately 2,100 rpm until the airspeed was too low to hold this speed (see paragraph 2.4).

The RH engine was shut down fifty seconds after reducing power to 0%, i.e. one minute fourteen seconds after the warning appeared (point 6). Once the engine was shut down, the propeller probably feathered[4].

The LH engine power lever was gradually moved to 100% and then pulled back in the final seconds to reduce power.

The temperature of the gearboxes of both engines remained below 85°C throughout the flight. There was therefore an inconsistency between the warning reported by the pilot in his statement (R GBOX TEMP) and the warning actually activated during the flight (R ENG TEMP).

2.8 Additional engine examinations

The engines were removed and inspected on the BEA’s premises. No operating anomaly was found on the LH engine.

During the examination of the RH engine, it was observed that the accessory belt was absent. Numerous quantities of belt residue were present nearby.

The aeroplane had been maintained in a Part 145 maintenance centre. The accessory belt on both engines had been changed on 23 February 2022 which corresponded to the recommendation to replace the belts every five years. The belts were replaced 18 months and less than 200 operating hours before the day of the accident.

The tensioner, alternator and water pump were inspected on Austro Engine's premises. The water pump and alternator were functional. No play or binding was observed in the various bearings. One of the belt tensioner pulleys had come out of its housing due to the deformation of the mounting bracket (see **Figure 7**).

[4] When the propeller speed exceeds 1,300 rpm, shutting down the engine causes the propeller to feather.

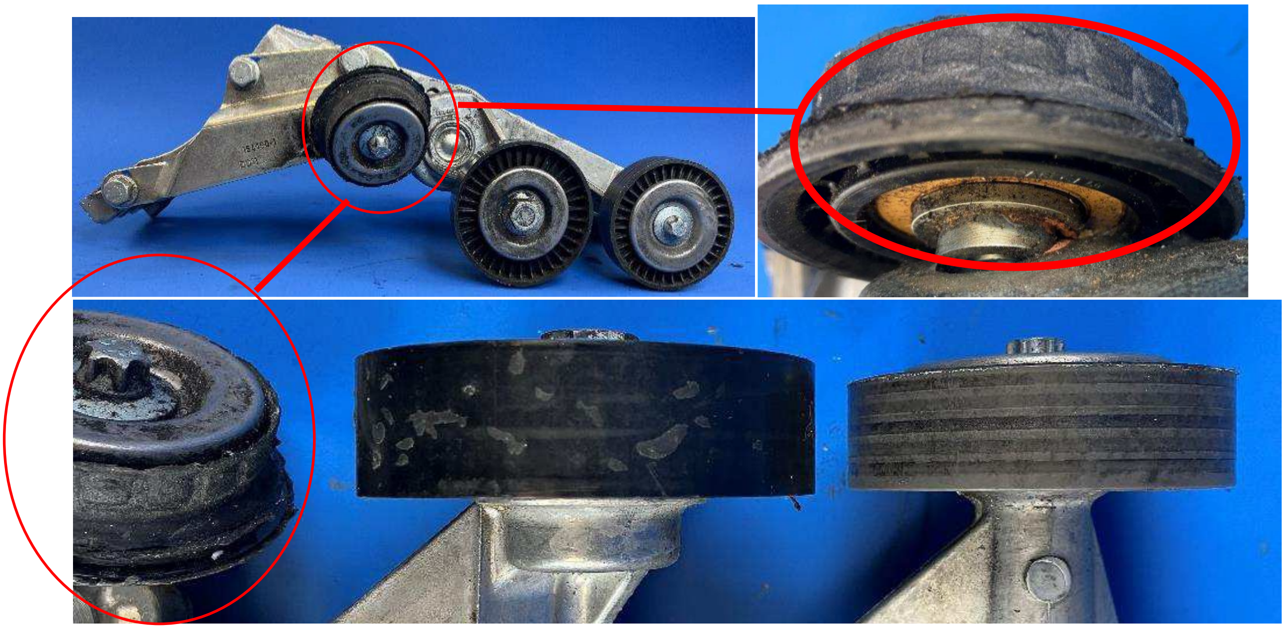

Figure 7: RH engine tensioner - pulley in red circle out of housing (source: BEA)

It was not possible to determine with certainty the causes behind the belt's separation.

The engine manufacturer and the BEA discussed and considered several hypothesis to determine the cause of the deformation of the belt tensioner and the belt coming out of position:

- transport related damage seems unlikely given the engine's operating time of 500 h;
- the belt was changed 18 months previously, it is thus unlikely that an incorrectly aligned belt or damage to the mounting bracket during maintenance were behind the failure;
- given the five-year service life of a belt, the hypothesis of a worn or damaged belt is also unlikely;
- a foreign object in the engine compartment could have led to damage to the pulley and belt during the operation of the engine. This foreign object could also have been the cause of the deformation to the mounting bracket and the resulting abrasions on the alternator.

The most likely hypothesis given the deformations observed and the age of the engine and the belt, is the ingress of a foreign object in the engine unit.

The results of the engine examinations are consistent with the parameters recorded during the accident flight and indicate the following sequence: the accessory belt of the RH engine separated shortly after take-off as evidenced by the drop in battery voltage; the water pump of the RH engine was no longer driven which led to a rise in the temperature of the coolant and the activation of the R ENG TEMP warning when this temperature exceeded 100°C.

BEA

2.9 Management of failure and emergency landing

2.9.1 AFM emergency procedures and corresponding checklists

The table below shows the two procedures in the AFM for the warning which was activated (LH side) and for the warning reported by the pilot in his statement (RH side).

3.2.2 L/R ENG TEMP L/R ENG TEMP — Left/Right engine coolant temperature is in the upper red range (too high/above 100 °C) Coolant temperatures above the limit value of 100 °C can lead to a total loss of power due to engine failure. - Check G1000 for L/R COOL LVL caution message (low coolant level) *L/R COOL LVL caution message not displayed:* During climb: - Reduce power on affected engine by 10% or more as required. - Increase airspeed by 10 KIAS or more as required. - If the coolant temperature does not reach the green range within 60 seconds, reduce power on affected engine as far as possible and increase airspeed. During cruise: - Reduce power on affected engine. - Increase airspeed. - Check coolant temperature in green range. **CAUTION** If high coolant temperature is indicated and the L/R COOL LVL caution message is not displayed, it can be assumed that there is no technical defect in the cooling system and that the above mentioned procedure can decrease the temperature(s). This might not be the case if the coolant temperature does not return to the green range. In this case, perform a precautionary landing on the nearest suitable airfield. Prepare for an engine failure in accordance with 3.7.6 - ENGINE FAILURES IN FLIGHT. **END OF CHECKLIST**	**3.2.5 L/R GBOX TEMP** L/R GBOX TEMP — Left/Right engine gearbox temperature is in the upper red range (too high/above 120 °C). Gearbox temperatures above the limit value of 120 °C can lead to a total loss of power due to engine failure. - Reduce power on affected engine. - Increase airspeed. **CAUTION** At high ambient temperature conditions, and/or at low airspeeds with high power settings, it can be assumed that there is no technical defect in the gearbox and that the above mentioned procedure will decrease the temperature(s). This might not be the case if the gearbox temperature does not return to the green range. In this case, perform a precautionary landing on the nearest suitable airfield. Prepare for an engine failure in accordance with 3.7.6 - ENGINE FAILURES IN FLIGHT. **END OF CHECKLIST**
Procedure for abnormal increase in coolant temperature	Procedure for increase in gearbox temperature

Figure 8: L/R ENG TEMP and L/R GBOX TEMP AFM procedures (source: Diamond Aircraft)

The table below shows the checklists normally available to the pilot in the aeroplane for these same warnings.

L/R ENG TEMP — COOLANT TEMPERATURE HIGH ➤ Check G1000 for LOW COOL LVL caution light ❖ If LOW COOL LVL caution light OFF ❖ **During climb:** ⇒ Reduce power on affected engine by 10% or more as required ⇒ Increase airspeed by 10 KIAS or more as required ● If coolant temp. not returning to green range within 60": ⇒ reduce power on affected engine as much as possible and increase airspeed ❖ **During cruise:** ⇒ Reduce power on affected engine ⇒ Increase airspeed ● If coolant temp. not returning to green range: ⇒ Be prepared for an engine failure; land at nearest suitable airfield ❖ If LOW COOL LVL caution light ON ⇒ Reduce power on affected engine ⇒ Expect loss of coolant fluid ⇒ Be prepared for an engine failure	DA62 — EMERGENCY PROCEDURES **L/R GBOX TEMP** ➤ Reduce power on affected engine ➤ Increase airspeed ● If gearbox temperature still in red range: ⇒ Land at nearest suitable airfield ⇒ Be prepared for an engine failure
Checklist for abnormal increase in coolant temperature	Checklist for increase in gearbox temperature

Figure 9: L/R ENG TEMP and L/R GBOX TEMP QRH checklists (source: Diamond Aircraft)

2.9.2 Management of failure

The R ENG TEMP failure light very probably illuminated while the aeroplane was climbing to an altitude of approximately 1,400 ft (i.e. a height of approximately 700 ft) on a VFR flight path, and both engines were at 86% power.

The L/R ENG TEMP procedure, associated with a coolant temperature warning, instructs the pilot, during the climb phase, to reduce the power of the affected engine by 10% or more as required, to increase the airspeed, to check the temperature decreases within 60 s and to continue reducing power and increasing airspeed if the temperature does not return to the green range.

The AFM specifies that if this does not occur, a precautionary landing must be made at the nearest suitable aerodrome and that the pilot must prepare for an engine failure.

The L/R GBOX TEMP procedure, associated with the warning reported by the pilot in his statement, is similar. It does not make a distinction between the warning appearing during climb or in cruise. It also requires the pilot to reduce power on the affected engine while increasing airspeed and, if the temperature does not return to the green range, to carry out a precautionary landing at the nearest suitable aerodrome, while preparing for an engine failure.

The pilot initially reduced power on both engines to 58% for ten seconds, then maintained 58% power on the LH engine while, in an eight-second period, reducing power on the RH engine to 0%. He then kept the engine at 0% for 50 s before shutting it down.

If these actions are compared to the prescribed procedure, it can be noted that power was initially reduced on both engines by more than 30%, and not by 10% just on the affected engine. In addition, the power reduction is held for ten seconds on the affected engine before being reduced to 0% whereas the procedure asks the pilot to wait sixty seconds to check whether the temperature decreases or not.

The L/R ENG TEMP procedure indicates that the pilot must reduce power on the affected engine **as required** and increase the airspeed. This emergency procedure may incite the pilot to totally reduce engine power. However, when power is reduced below a certain threshold (zero thrust condition, where thrust compensates the drag), and the propeller is not feathered, this latter condition generates substantial residual drag and induces flight asymmetry which affects climb performance. The asymmetry will be more than that of one engine inoperative with the engine shutdown and the propeller feathered.

The L/R GBOX TEMP procedure and checklist, even if their wording is different, do not specify a power reduction limit either.

These procedures and associated checklists were being revised by Diamond Aircraft at the time of publication of this report.

In this occurrence, the management of the warning required immediate but moderate action (reduction of 10% or more for 60 s on a single engine) and the performance of the aeroplane would normally have allowed the climb to continue with a 10% reduction on one engine or, with one engine inoperative, the engine shutdown and secured. The pilot's large-amplitude inputs on the affected engine in a short time interval demonstrate an overreaction in both magnitude and timing. This type of overreaction can be symptomatic of stress. Furthermore, these inputs participated in degrading the aeroplane's performance

2.9.3 One engine inoperative - Emergency landing

The procedure specifies feathering the propeller of the affected engine, establishing minimum sideslip conditions and increasing the power on the operative engine if necessary.

3.7.6 ENGINE FAILURES IN FLIGHT

(a) Engine Failure During Initial Climb

WARNING

As climb is a flight condition which is associated with high power settings, airspeeds lower than v_{MCA} = 76 KIAS (flaps UP) or 70 KIAS (flaps T/O) should be avoided as a sudden engine failure can lead to loss of control. In this case, it is very important to reduce the asymmetry in thrust to regain directional control.

1. Rudder. . . . . maintain directional control
2. Airspeed . . . . v_{YSE} = 87 KIAS up to 1999 kg (4407 lb)
89 KIAS above 1999 kg (4407 lb)
3. Operative engine . . . . increase power as required if directional control has been established

Establish minimum/zero sideslip condition. (approx. half ball towards good engine; 3° to 5° bank).

4. Inoperative engine . . . . Secure according to 3.7.3 - ENGINE SECURING (FEATHERING) PROCEDURE

Land as soon as possible according to 3.7.7 - LANDING WITH ONE ENGINE INOPERATIVE. If a diversion is required before landing, continue according to Section 3.7.9 - FLIGHT WITH ONE ENGINE INOPERATIVE.

END OF CHECKLIST

5.3.9 ONE ENGINE INOPERATIVE CLIMB PERFORMANCE

Conditions:

- Remaining engine . . . . 95% load
- Dead engine . . . . feathered and secured
- Flaps. . . . . UP
- Landing gear. . . . . retracted
- Airspeed . . . . v_{YSE}
- Sideslip. . . . . one ball out, max. 5° bank

NOTE

With respect to handling and performance, the left-hand engine (pilots view) is considered the "critical" engine.

The climb performance tables show the rate of climb. The gradient of climb can be calculated using the following formula:

$$Gradient\ [\%] = \frac{ROC\ [fpm]}{TAS\ [KTAS]} \cdot 0.98$$

Figure 10: engine failure during initial climb (source: Diamond Aircraft)

The pilot kept the RH engine at 0% and increased the power of the LH engine again. When he shut down the RH engine, he was at an altitude of around 1,000 ft (i.e. a height of around 200 ft). The yaw trim had probably stayed in the take-off position (slightly to the RH side of the centre position) and was probably not used to minimise sideslip during the occurrence.

3 CONCLUSIONS

The conclusions are solely based on the information which came to the knowledge of the BEA during the investigation.

Scenario

The pilot and his passenger took off from Nancy - Essey airport. Less than two minutes after taking off, at a height of around 700 ft, and in a LH turn, while the pilot was turning in the runway circuit, a R ENG TEMP warning appeared. The pilot reported on the radio that he had an engine problem and was returning to the airfield.

The analysis of the parameters and the examination of the engine found that the accessory belt of the RH engine had separated during take-off which caused the coolant temperature to increase beyond the warning limit and activated the L/R ENG TEMP warning (see paragraph 2.8).

The pilot indicated in his statement that he initially complied with the L/R GBOX TEMP checklist from memory.

In his management of the failure, the pilot began by reducing power on both engines. He kept reduced power on the LH engine and totally reduced power on the RH engine without shutting it down. The additional asymmetry linked to the reduction of power below the zero thrust condition (where thrust compensates drag) made the flight path difficult to control. In addition to this asymmetry, not using the available power on the LH engine compromised the chances of maintaining level flight or continuing the climb with one engine inoperative.

Believing that the performance was degraded, the pilot abandoned the attempt to continue to the runway and opted for an off-airfield emergency landing.

During the landing, the pilot lost control of his aeroplane which collided with vegetation. The examination of the wreckage found that the yaw trim was centred and slightly to the right. In this position, the RH yaw induced by the flight asymmetry with the RH engine shut down made the aircraft more difficult to control.

Contributing factors

The factors that may have contributed to the engine problem, i.e. the separation of the accessory belt of the RH engine were not identified during the investigation.

In the absence of an interview with the pilot, it was not possible to explain all the pilot's actions and in particular, the reduction in power on both engines at the beginning of the management of the failure and then the total reduction in power on one engine without immediately shutting it down.

The following factors may have contributed to the non-optimal management of the failure and to the degradation of the aeroplane's performance:

- possible stress associated with managing a failure in climb at a low height, which led to large-amplitude and hasty inputs which affected the control of the flight path;
- no power reduction limit being specified in the L/R GBOX TEMP procedures (initially complied with from memory by the pilot and then with the written procedure) and the L/R ENG TEMP procedures, which could lead a pilot to reduce engine power without shutting it down below the zero thrust condition (where thrust compensates drag).

It was not possible to determine whether the confusion between the two warnings occurred during the flight or was an error in the pilot's written statement. In any case, the confusion between the two warnings probably did not have a significant impact on the management of the occurrence.