INCIDENT TO
DIAMOND DA 42
AT EBAW
ON 25 APRIL 2012

Ref. AAIU-2012-10
Issue date: 18 March 2013
Status: Final
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FOREWORD

This report is a technical document that reflects the views of the investigation team on the circumstances that led to the accident.

In accordance with Annex 13 of the Convention on International Civil Aviation and EU Regulation 996/2010, it is not the purpose of aircraft accident investigation to apportion blame or liability. The sole objective of the investigation and the Final Report is the determination of the causes, and define recommendations in order to prevent future accidents and incidents.

In particular, Article 17-3 of the EU regulation EU 996/2010 stipulates that the safety recommendations made in this report do not constitute any suspicion of guilt or responsibility in the accident.

Unless otherwise indicated, recommendations in this report are addressed to the Regulatory Authorities of the State having responsibility for the matters with which the recommendation is concerned. It is for those Authorities to decide what action is taken.

The investigation was conducted by Henri Metillon and Sam Laureys, with the support of BFU Germany and Thielert Aircraft Engines GMBH.

The report was compiled by Henri Metillon and was published under the authority of the Chief Investigator.

NOTES:

1. For the purpose of this report, time will be indicated in UTC, unless otherwise specified.

2. ICAO document 9859 “Safety Management Manual” was used to identify the hazard and the consequences related to the accident.
<table>
<thead>
<tr>
<th>Symbol</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>'</td>
<td>Minute</td>
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<tr>
<td>°</td>
<td>Degree</td>
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<tr>
<td>°C</td>
<td>Degrees centigrade</td>
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<td>Feet</td>
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<tr>
<td>AAIU(Be)</td>
<td>Air Accident Investigation Unit (Belgium)</td>
</tr>
<tr>
<td>ACREP</td>
<td>Accredited Representative of an Investigation Unit</td>
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<td>Above Sea Level</td>
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<td>Belgian Civil Aviation Authority</td>
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<tr>
<td>BFU</td>
<td>German Federal Bureau of Aircraft Accident Investigation</td>
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<tr>
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<td>Brake horsepower</td>
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<td>EASA</td>
<td>European Aviation Safety Agency</td>
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<tr>
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<td>Airport Antwerpen/ Deurne</td>
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<tr>
<td>EBKT</td>
<td>Airport Kortrijk/ Wevelgem</td>
</tr>
<tr>
<td>EBOS</td>
<td>Airport Oostende</td>
</tr>
<tr>
<td>ECU</td>
<td>Engine Control Unit</td>
</tr>
<tr>
<td>Engine #1</td>
<td>Left hand engine</td>
</tr>
<tr>
<td>Engine #2</td>
<td>Right hand engine</td>
</tr>
<tr>
<td>FAA</td>
<td>Federal Aviation Administration</td>
</tr>
<tr>
<td>FADEC</td>
<td>Full Authority Digital Engine Control</td>
</tr>
<tr>
<td>ft</td>
<td>Foot (Feet)</td>
</tr>
<tr>
<td>Flight Time</td>
<td>Time “block to block”</td>
</tr>
<tr>
<td>KIAS</td>
<td>Knots Indicated Airspeed</td>
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<tr>
<td>KTAS</td>
<td>Knots True Airspeed</td>
</tr>
<tr>
<td>lbs</td>
<td>Pounds</td>
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<tr>
<td>m</td>
<td>Meter(s)</td>
</tr>
<tr>
<td>MAP</td>
<td>Manifold Air Pressure</td>
</tr>
<tr>
<td>METAR</td>
<td>Meteorological Aerodrome Report</td>
</tr>
<tr>
<td>nm</td>
<td>Nautical mile(s)</td>
</tr>
<tr>
<td>O/H</td>
<td>Overhaul</td>
</tr>
<tr>
<td>PIC</td>
<td>Pilot In Command</td>
</tr>
<tr>
<td>POH</td>
<td>Pilot’s Operating Handbook</td>
</tr>
<tr>
<td>PRail</td>
<td>Fuel pressure inside the engine common rail</td>
</tr>
<tr>
<td>QFU</td>
<td>Magnetic bearing of the runway</td>
</tr>
<tr>
<td>QNH</td>
<td>Pressure setting to indicate elevation above mean sea level</td>
</tr>
<tr>
<td>RPM</td>
<td>Revolutions per Minute</td>
</tr>
<tr>
<td>RWY</td>
<td>Runway</td>
</tr>
<tr>
<td>SEP</td>
<td>Single Engine Piston rating</td>
</tr>
<tr>
<td>SL</td>
<td>Sea Level</td>
</tr>
<tr>
<td>TAE</td>
<td>Thielert Aircraft Engines GMBH (Engine manufacturer)</td>
</tr>
<tr>
<td>TIS</td>
<td>Time in Service (From take-off to landing)</td>
</tr>
<tr>
<td>US Gal</td>
<td>US Gallon</td>
</tr>
<tr>
<td>UTC</td>
<td>Universal Time Coordinated</td>
</tr>
<tr>
<td>V</td>
<td>Volt</td>
</tr>
</tbody>
</table>
**SYNOPSIS**

**Date and hour of the incident:** 25 April 2012 at 7:07

**Aircraft:** Diamond DA 42

**Incident location:** EBAW airport

**Aircraft owner:** TLA N.V.

**Operator:** CAE Oxford Aviation Academy Brussels

**Type of flight:** Training

**Persons on board:** 3

**Abstract:**
After refuelling and performing a pre-flight check without any findings, the airplane took-off from EBAW airport.
The first part of the take-off was uneventful, but in crosswind leg at approx. 400 ft AGL, the crew noticed a yaw to the right and a loss of RPM and load on engine #2. The instructor observed a white smoke coming out of the nacelle of the engine. He considered this as being an engine fire and took over controls. He switched off the master switch of engine #2 whereupon the propeller blades were feathered correctly. In downwind, he made a mayday call to EBAW TWR, stating they had an engine fire and requested a clearance for an emergency landing.
The landing further happened uneventful except that there was no nose gear green light indication (While the nose wheel landing gear was actually extended and secured).

**Cause(s):**
The probable cause of the engine failure is a contamination of the engine clutch by coolant spillage during the last maintenance operation. The contamination could penetrate in the clutch housing through an opening located under the coolant tank that was only closed by a not fluid-tight plastic cover.

**Hazard identified during the investigation**¹:
Possible contamination of the engine clutch as installed in a not fluid-tight housing.

**Consequence**²:
Engine failure (SCF-PP)

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¹ Hazard – Condition or object with the potential of causing injuries to personnel, damage to equipment or structures, loss of material, or reduction of ability to perform a prescribed function.
² Consequence – Potential outcome(s) of the hazard
1 Factual information.

1.1 History of flight.

This flight was intended as an IFR multi-engine training flight with instructor for 2 student pilots following the ab initio ATPL training program. This flight was also the first flight of the 2 student pilots on Diamond DA 42 with TAE engines.

After refuelling and performing a pre-flight check without any findings, the airplane took-off from EBAW airport. During the take-off run, the instructor, who was sitting on the right hand seat, noticed that engine #2 spooled up slower than engine #1, but according to him this was still within limits as the engine reached 100% RPM in time. The first part of the take-off was uneventful, but in crosswind leg at approx. 400 ft AGL, the crew noticed a yaw to the right and a loss of RPM to 2300 and a loss of load to 55-60% on engine #2. The instructor observed a white smoke coming out of the nacelle of the engine #2. He considered this as being an engine fire and took over controls. He switched off the master switch of engine #2 whereupon the propeller blade was feathered.

After this, he switched off the engine #2 alternator and the right-hand fuel selector as per recall actions of an engine failure/fire.

In downwind, he made a mayday call to EBAW TWR, stating they had an engine fire and requested a clearance for an emergency landing.

The landing further happened uneventful except that there was no nose gear green light indication, while the nose wheel landing gear was actually extended and secured.

After landing, the runway was vacated and after passing the runway 29 holding position marking, they made a full stop and shut down engine #1.

The instructor and the students disembarked the aircraft and the airfield fire department inspected the aircraft. A strong burning smell was sensed but no fire observed.

Figure 1: airplane flight path
1.2 Injuries persons.

<table>
<thead>
<tr>
<th>Injuries</th>
<th>Pilot</th>
<th>Passenger</th>
<th>Others</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Serious</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Minor</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>None</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

1.3 Damage to aircraft.

Excepted the engine #2, the airplane was undamaged.

1.4 Other damage.

No damage

1.5 Personnel information.

Pilot:
Sex: Male
Age: 31 years old
Nationality: Belgian
License:
Airline Transport Pilot Aeroplane license first delivered on 02 February 2011.
Ratings: SEP(land), MEP(Land) and A320 valid until 31 November 2011.
CRI(A), FI(A) and IRI(A) valid until 28 February 2012.
English: unlimited validity.
Medical Certificate: Class I. Certificate valid until 04 November 2011.
Experience: Approximately 6500 FH total time, of which 2450 FH pilot in command and 5400 FH IFR. 2000 FH SEP Land and 520 FH MEP Land.

1.6 Aircraft information.

Airframe
Manufacturer: Diamond Aircraft Industries GmbH
Type: DA 42
Serial number: 42.086
Built year: 2006
Certificate of registration: N° 10040, delivered by Belgian CAA
Certificate of airworthiness: EASA Form 25, delivered by Belgian CAA on 30 March 2006
Airplane total time: 1004 FH
The Diamond DA42 Twin Star is a four seat, twin engine, propeller-driven airplane manufactured by Diamond Aircraft Industries.

Its airframe is molded largely of composite materials.

It can be equipped, among other with two 1.7L Centurion diesel engines manufactured by TAE.

The “TAE Centurion 1,7” engine is a 1.7 liter turbo charged, 4 cylinder common rail diesel engine controlled by a FADEC system. It is operated through a single lever power control and is equipped with a reduction gearbox (Reduction ratio 1,69/1). The engine is designed to run in conjunction with a variable pitch propeller. Maximum engine RPM is 3900 and maximum propeller RPM is 2300. The RPM indicator shows propeller RPM values for the pilot. However, the RPM indicator system actually measures the engine RPM (thru crankshaft sensors) from which the values are corrected (fixed reduction ratio 1,69/1) and showed as being propeller RPM. An overload clutch is installed to transfer the engine power from the crankshaft to the gearbox. The purpose of the clutch is to decouple engine vibrations from the propeller and to decouple the rotating mass of the propeller from the crankshaft to limit the impact load during startup and shutdown.

**Engines**

- **Manufacturer:** Thielert Aircraft Engines
- **Type:** TAE 125-01(TAE Centurion 1,7)
- **Total flight hours:** 190:30 (Time in service) which correspond to around 248h total running time.
- **Serial number:** Engine (#1): 02-01-1176  
  Engine (#2): 02-01-1177

**Certificate of Registration:** N° 10040, delivered by Belgian CAA.

**Certificate of airworthiness:** EASA Form 25 delivered by Belgian CAA on 30 March 2006.

**Airworthiness review certificate:** EASA Form 15 B valid until 04 April 2013

**Maintenance and last flights:** The airplane was regularly maintained in a Belgian CAA approved Part M Subpart F maintenance organization. The same maintenance organization, being also a Part M Subpart G approved organization, was also in charge of the airworthiness review of the airplane.

In 2006, both original engines were removed and replaced by new engines.
The following last maintenance operations were performed:

- **October 2011:** “1000 h” maintenance performed + Clutch of engine #2 replaced by a new type in accordance with EASA AD 2011-0152-E and SB TM TAE 125-0021 Rev1. (New clutch type identification: PN: 05-7211-K009406). A small oil seepage was found around the crankshaft after the removal of the old clutch, therefore a new crankshaft sealing ring was installed before installing the new clutch assembly.
  
  The above maintenances were performed at EBKT airport at 1001h A/C Time in Service.

- **9 March 2012:** Wing fuel drain replaced + Garmin upgrade at 1001,7h A/C Time in Service. (Location: EBOS airport).

- **10 March 2012:** Two local flights at EBOS airport (A/C Time in Service 1001,7 => 1003,3).

- **13 March 2012:** Ferry flight EBOS => EBKT (from 14h21 to 14h53)

- **21 April 2012:** A few calendar time related maintenance tasks were performed by the maintenance organization at EBKT, among other the coolant replacement + FADEC reinstallation after “maintenance” done by TAE + the airplane assessment for the renewal of “Airworthiness Review Certificate” (A/C Time in service 1003,5).

- **21 April 2012:** Last flight before incident flight: ferry flight EBKT => EBAW (Around 35 minutes Time in Service - 51 minutes engine running time)

- **25 April 2012:** Engine #2 failure after take-off due to slipping and burning of the engine clutch (A/C Time in Service: 1004,2).

### 1.7 Meteorological conditions.

<table>
<thead>
<tr>
<th>Time</th>
<th>METAR Details</th>
</tr>
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<tbody>
<tr>
<td>06:50 UTC</td>
<td>METAR COR EBAW 250650Z 17011KT 9999 FEW012 08/05 Q0999 NOSIG=</td>
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<tr>
<td>07:20 UTC</td>
<td>METAR EBAW 250720Z 16011KT 9999 FEW015 09/05 Q0999 NOSIG=</td>
</tr>
</tbody>
</table>

As seen on the above METAR, the meteorological conditions at EBAW airport were obviously adequate to perform VMC flights (Wind 11 knots, wind direction around 165°, visibility more than 9999m and a few clouds between 1200’ and 1500’).

### 1.8 Aids to navigation.

Not applicable

### 1.9 Communication.

A normal communication was established with “Antwerpen GND” for taxiing and later with “Antwerpen TWR” for take-off clearance.

In downwind, the pilot made a mayday call to EBAW TWR, stating they had an engine fire and requested a clearance for an emergency landing.

Priority to land was given by EBAW TWR to OO-TLA.
In base leg, the instructor pilot observed the absence of the nose gear extension green light after having moved down the landing gear control switch.

The pilot asked the tower to visually check the extension of the nose landing gear. It was confirmed that the nose gear was extended.

1.10 Aerodrome information.

The airport of Antwerpen is located at 2,9 Nautical Miles (5.4km) SE of the city of Antwerpen, on the coordinates 511122N - 0042737E. The elevation is 39ft (11.9m ASL).

The airport has one bi-directional runway oriented 11/29 with hardened asphalt. (Strength PCN 30/F/A/W/U). Dimensions of the runway are 1510m long x 45m wide.

The airport is provided with Antwerpen TWR (135.200 MHz) and Antwerpen GND (121.900 MHz) ATS communication facilities.

1.11 Flight recorders.

The airplane is not equipped with a flight recorder, but the TAE-125 engine is equipped with an Engine Control Unit (FADEC) that keeps some engine parameters in memory for the last running time. Moreover, the maintenance organization downloaded regularly the FADEC parameters after each significant maintenance operation.

The downloaded engine parameters are not directly readable and the read out in Excel format was performed with the support of a BFU Investigator (ACREP).

In November 2011, the parameters of engine #2 had been downloaded by the maintenance organization after the clutch replacement.

On 25 April 2012, the parameters were downloaded after the clutch failure. The last 1 hour 58 minutes engine running time were available, beginning with the engine test performed after the FADEC reinstallation (and before the coolant replacement) up to and including the engine failure.

Note: among other, the following parameters are recorded: Revolutions (RPM), Load (Throttle position), MAP, TH2O, TAir, TOil, POil, PRail, PBaro and Time. All the parameters are recorded at a frequency of one Hertz.

Additionally, the following events log readout was downloaded. The last line dated 25/04/2012 relates to the engine failure and shows a High RPM event for only 2.2 seconds which was recorded for "Info Only". No ECU Warning was triggered.
1.12 Wreckage and impact information.
   Not applicable

1.13 Medical and pathological information.
   Not applicable

1.14 Fire.
   There was no fire, however an heavy burning odour was perceptible around the airplane after the engine failure.

1.15 Survival aspects.
   Not applicable

1.16 Tests and research.
   Not applicable

1.17 Organizational and management information.
   Not applicable

1.18 Additional information.
   The original clutch of the engine (#2) SN: 02-01-1177 had to be removed from service within the next 50 Flight Time after 22 August 2011 in accordance with EASA AD 2011-0152-E because the clutch was affected by SB TM TAE 125-0021 Rev1.

   The reason of this replacement was the identification of a batch of Belleville washer / disk springs which received a non-conforming heat treatment process.

   EASA AD 2011-0152-E requested the replacement of the clutch assembly PN: 02-7210-11001R13 with a serviceable part (possibly of the same model and PN) while SB TM TAE 125-0021 Rev1 requested the replacement of the clutch assembly with a “new style” clutch assembly in accordance with chapter 05.1 of the current Repair Manual RM-02-01 entitled “Replacing the old clutch”.

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Event Log read 25/04/2012 14:02:04 from FADEC #3156

FADEC-A Events in chronological order:
18/04/2012 17:07:51 - Info only: Warnings cleared
18/04/2012 17:08:02 - Info only: Warnings cleared
21/04/2012 09:18:26 - Info only: ValvePower current too high
21/04/2012 11:45:28 - Info only: ValvePower current too high
25/04/2012 09:07:23 - Info only: High RPM: up to 4562 rpm for 2,2 seconds
EASA AD 2011-0152-E was performed in October 2011 by installing the new design clutch type PN: 05-7211-K009406 in the engine (#2) SN: 02-01-1177.

1.19 Useful or effective investigation techniques.
Not applicable
2 Analysis.

2.1 Engine inspection

Two AAIU(Be) investigators arrived at EBAW airport the day of the incident for interviewing the instructor pilot and the EBAW airport inspection service and also for the first investigation of the airplane.

In the afternoon, an engineer of the maintenance organization arrived in the airport in order to assess the problem and to repair the engine. Investigators asked his support for the first step of the investigation and for downloading the data from the Engine Control Unit of engine #2.

The download of the last flight hours was immediately performed.

The airplane was stored in a hangar and a burning smell was perceptible around the whole airplane but more strongly near the engine #2.

The cowlings of engine #2 were removed for an external inspection of the engine. A brown trace of fume and/or fire was visible under the engine starter. The fumes originated obviously from the engine clutch area, through a non-tight plastic cover.

![Figure 2: Smoke traces](image1)

![Figure 3: Location of smoke traces](image2)

The propeller and the gear box were removed in accordance with Repair Manual TAE 125-01 RM-02-01 Chapter 05.2. to gain access to the clutch. The clutch was found significantly damaged and burned showing a lot of burned residues and some blue metallic coloration on the fixed friction plate, typical of steel overheating.

Special attention was paid at this stage of the dismantling to verify the correct installation of the different parts.
The fixed pressure plate was properly positioned in the "LOCK" position as per figure 34 of Manual TAE 125-01 RM-02-01 Chapter 05.1.
The position of the clutch was found to be installed following figure 29 of Manual TAE 125-01 RM-02-01 Chapter 05.1 (The label "Motorseite – Flywheel-side" was facing to engine). No anomaly of installation was found.

The fixed pressure plate was turned counter clockwise and removed, showing the burned friction disk.

Thereafter, the friction disk was removed excepted that the rear friction lining (Flywheel side) of the friction disk remained “glued” on the movable pressure plate of the flywheel.

Obviously the friction linings of the friction disk were entirely worn out by slipping and destroyed by subsequent overheating.
We found some evidences inside the clutch housing that a contamination by fluid occurred. As seen on the above pictures, the traces are visible under the opening located near the starter and on the rear side of the flywheel.
The opening was closed by a plastic cover, but this cover was obviously not designed to be fluid tight.

A fluid could have entered the clutch housing through the plastic cover, and further on to the friction surfaces through the openings of the flywheel, causing the system to slip and eventually fail. The traces of fluid running, as indicated on the figures 9 and 10 above were dry (not oily).

Some contamination traces were also found on the internal surface of the gear box, under the clutch shaft coupling area. The contamination could originate from a small oil leak coming from the gearbox. Further examination of the gearbox and the clutch were performed at the factory under supervision of the BFU accredited representative.

![Image of internal side of gear box](image)

Figure 11: Internal side of the gear box showed also traces of fluid contamination located under the clutch shaft coupling area.

Conclusion of the engine examination
Traces of contamination were found under an opening located inside the clutch housing, on the rear side of the flywheel and under the shaft coupling of the gearbox.
No installation error of the recently installed clutch assembly was detected.
2.2 FADEC parameters analysis

Parameters downloaded in November 2011 after the installation of the new clutch.

The engine parameters of engine #2 had been downloaded on 02 November 2011 by the maintenance organization after the installation of the new style clutch. Their analysis allows to see the engine behaviour before and after the installation of the new style clutch.

The first graph hereunder (Fig 12) shows the engine before the replacement of the clutch, at full throttle for around 15 seconds. The engine RPM is relatively stable excepted two small peaks possibly originating from wind gusts.

The second graph (Fig 13) shows also the engine at full throttle after the installation of the new style clutch. The engine RPM is very stable but the engine runs 100 RPM higher than during the previous test, possibly due to better meteorological condition (lower temperature and higher barometric pressure.)
From both above graphs, we can deduct that the engine behaviour was normal as well before than after the installation of the new style clutch.
Parameters downloaded on 25 April 2012 after the engine failure.
The parameters downloaded after the engine failure were available for the last 1 hours 58 minutes engine running time up to and including the engine failure.

The downloaded parameters (Excel file of 10300 lines) were carefully investigated in order to find possible pre engine failure anomalies.

The analysis confirms that two engine tests and two flights were performed during the last 1 hour 58 minutes engine running time. The engine tests were made before and after the maintenance performed on April 2012 (coolant replacement …), followed by the ferry flight EBKT => EBAW and finally the engine failure during the take-off at EBAW airport.

Engine test made before the maintenance performed on April 2012.
The first part of the downloaded records (run up before the maintenance) was investigated and no anomaly was found. The following graph (Fig 14) extracted from this file shows the RPM parameter (vs time in second) at full load (99.9%) for 20 seconds at engine full throttle.

During the first 10 seconds at full power, the engine RPM increased gently from 3845 RPM to 3885 RPM and thereafter ran very stable for the next 7 seconds before the engineers reduced the throttle position.

![RPM full throttle before coolant replacement](image)

Figure 14: engine full throttle RPM before replacement of the coolant.

Engine test made after the maintenance performed on April 2012 (Fig 15).
When the throttle was set to full load the first time after the maintenance, the RPM went in overspeed for around 4 seconds before the engineer moved the throttle position backwards. The engineer who made the engine test reported later that gust wind was present when he performed the engine test. Therefore, believing the overspeed was due to a wind gust, he reduced the throttle position, awaiting a moment that wind gusts would disappear.
No “ECU Failure” warning was activated by the FADEC.
Figure 15: engine first full throttle RPM after replacement of the coolant

The next graph (Fig 16) hereunder shows the RPM parameters at full load on ground beginning 98 seconds after the above overspeed, during the same engine run-up.

As seen on the above graph (Fig 16) the engine speed is (a little) less stable than the one performed before the maintenance (figure 14) however, no obvious overspeed occurred.
Taking into account that either no new obvious overspeed occurred nor any “ECU Failure” warning, the engineer performing the engine test considered the engine test as satisfactory.

**Ferry flight EBKT => EBAW.**

![RPM Full Throttle take-off EBKT => EBAW](image)

Figure 17: engine full throttle RPM during take-off at EBKT airport

The graph on Fig 17 shows that the pilot applied full throttle during 44 seconds during the take-off for the ferry flight EBKT => EBOS. After 9 seconds, the engine RPM was beyond 4000 RPM and remained above this value for 6 seconds. During the 44 seconds period of time full throttle was applied for the take-off, the engine ran 16 seconds above 3950 from which 6 seconds above 4000 RPM.

The pilot neither reported any anomaly or “ECU Failure” warning.

**Taxi of the airplane from the hangar to the refueling station.**
During the taxi run, maximum 25% load was applied and no anomaly occurred.
Take-off and engine failure (Fig 18, 19 and 20).
A first significant overspeed up to 4300 RPM occurred when the pilot selected full throttle. This overspeed was immediately followed by an RPM drop of around 700 RPM before reacceleration and stabilizing a few seconds later to 3950 RPM.

Around 45 seconds later, a second overspeed occurred up to 4040 RPM followed by a limited RPM drop of a few seconds.

The most significant overspeed began when the airplane was already in flight, around 70 seconds after full take-off power was applied. The overspeed extended up to around 4500 RPM.

The first and the last overspeed were immediately followed by a reduction of both the MAP and the PRail, probably controlled by the ECU.

Figure 18: engine full throttle RPM during take-off at EBAW airport
The throttle load remained on 99% all the time meaning the drop of RPM was slipping of the clutch followed by a drop of RPM.

When the student pilot applied full throttle for the take-off run, the instructor had the impression that engine #2 sped-up slower than engine #1, although the ECU data shows the opposite. Actually, there was an overspeed due to a first slipping of the clutch followed by a drop of RPM.

The throttle load remained on 99% all the time meaning the drop of RPM was due to an ECU adjustment of the MAP, the Pressure Rail and other parameters to protect the engine against overspeed.

Taking into account the engine stabilized soon after to 3950 RPM and there was no “ECU Failure” warning, the instructor considered the situation as acceptable and did not find necessary to abort the take-off.
After the take-off, the airplane being in crosswind leg at approximately 400 ft AGL, the student and the instructor pilot noticed a yaw to the right and a significant loss of power of the #2 engine. This was due to a failure of the clutch to transfer the available engine power to the propeller.

**Conclusion of the FADEC parameters analysis**
- The engine and the clutch behaviour were found degraded for the first time during the test of the engine performed after the last maintenance operation dated 21 April 2012.
- No sign of engine or clutch degradation was visible during the Ferry flight EBKT => EBAW performed on 21 April 2012, after the maintenance operation.
- No “ECU Failure” warning signal was activated by the FADEC in order to warn the engineer and/or the pilot up to and including after the engine failure. As seen in § 1.11, the ECU warning system did not detect the gravity of the event. It only identified a high RPM value for a short period, corresponding to the engine failure and quoted as “Info Only”.

### 2.3 Maintenance records analysis
The following interesting maintenance operations were performed beginning in October 2011:

- **October 2011**: “1000 h” maintenance performed + Clutch of engine (#2) SN: 02-01-1177 replaced by new (A/C Time in service 1001h).
- **21 April 2012**: A few calendar time related maintenance tasks were performed by the maintenance organization at EBKT, among other the coolant replacement and the maintenance of the FADEC. (A/C Time in service 1003,5). To the best of our knowledge the FADEC was sent to TAE for the purpose of calendar time maintenance of the hardware only. The software was not affected by the maintenance (Mapping-B48 R28V291D and Firmware-B0). Therefore, no relationship between the FADEC maintenance and the clutch failure was found.
- **25 April 2012**: Engine #2 failure after take-off due to slipping and burning of the engine clutch (A/C Time in Service: 1004,2).

### 2.4 Clutch and gear box analysis
The clutch and the gear box were removed from the engine by the maintenance organization the day of the incident, on 24 April 2012 (Parts removal witnessed by AAIU(Be)). As arranged with TAE on 26 April 2012, the maintenance organization sent the clutch and the gear box for analysis.

A notification was sent by AAIU(Be) on 26 April 2012 to different investigation stakeholders, among other the BFU.

On Friday 27 April 2012, a BFU Accredited Representative was designated and the ACREP informed AAIU(Be) that he had nominated a member of TAE as
The same day, the advisor informed AAIU(Be) and the maintenance organization that he found it necessary to send the entire engine in order to perform a more complete and effective investigation.

AAIU(Be) informed and requested the maintenance organization and the owner to send the entire engine to the manufacturer. Unfortunately, the airplane owner and the maintenance organization did not agree to send the engine to the manufacturer regarding the significant cost of the operation and the supposed extended delay to repair the airplane.

On 7 May 2012, the engine was again carefully inspected by AAIU(Be) and the traces of contamination mentioned in chapter 2.1 (Fig 10) were found. The pictures taken during the parts removal were also carefully analyzed and additional (but limited) traces of contamination were detected on the rear side of the flywheel and also on the gear box internal face (Fig 9 and 11).

From that time the hypothesis of a fluid contamination coming through the opening located near the starter was given preference and the need to send the engine to the manufacturer was determined to be less imperative.

On the same way, the analysis of the damaged clutch and the gear box was from that moment considered as a way to consolidate the hypothesis of a fluid contamination coming through the opening located near the starter.

The analysis of the clutch and the gear box by TAE (Document No.: 02-0001-7200-BEF-IR-01 dated 04 January 2013) confirmed the hypothesis of a probable clutch contamination by fluid. The fluid could enter the clutch housing through the opening in the crankcase.

TAE could also determine that the oil contamination on the internal side of the gear box (Figure 21) resulted from a damage of the sealing ring of the driven shaft by debris coming from the slipping friction disk.

Additionally TAE had also found that the banjo of the vent line of the gear box was cracked and had identified limited traces of oil contamination down to the oil filler plug (The vent line and oil filler plug are located in the same area).

**Conclusion of the clutch and gear box analysis by TAE.**

> To sum up it could be said that the burned friction disk was caused due to a high slip. The slip resumed from a contamination of the friction disk with a fluid. The marks located at the backside of the clutch housing are caused by a cleaner which dropped into the clutch housing by the crankcase opening below the starter. There is also a sign of an oily liquid down to the oil filler plug. The oily liquid may also cause such a trouble. A fuel leakage from injector drain could be excluded. The drain line was in correct position. The leakage at the gearbox was a subsequent error. Debris originated by the slipping friction disk destroyed in effect the sealing ring.

### 2.5 Hypothesis

**Cleaning product contamination**
During the investigation it was found that the engine itself was very clean on the outside, while fluid contamination traces were found inside the flywheel housing. Therefore the hypothesis of a cleaning product contamination was examined. It was demonstrated by the maintenance records that a cleaning product (“Varsol”) was used during the clutch replacement performed in October 2011.

However, the full throttle graph after the installation of the new clutch (Figure 13) shows that the engine ran very stable at 3900 RPM after the cleaning of the engine, without any sign of slipping.

Additionally, no indication could be found that a cleaning product was used later and the maintenance organization also confirmed they didn’t clean the engine during the next maintenance operation dated April 2012.

Therefore, the hypothesis of a contamination by cleaning product was considered unlikely.

Note: Varsol is not approved for the cleaning of the engine. Evaporation characteristics might be different and should be compared by the maintenance organization before use.
Coolant liquid contamination.
On the other way, the engine coolant liquid was replaced during the last maintenance operation performed in April 2012 (and the FADEC was sent to the manufacturer for maintenance).

As seen on the hereunder picture (Fig 22), the coolant tank is located above the clutch housing opening, the one being closed by a not fluid-tight plastic cover.

![Coolant Tank Diagram](image)

**Figure 22**: view of the relative position of the coolant tank regarding the opening in the clutch housing

Therefore the possibility does exist that spillage occurred during the filling of coolant that penetrated inside the clutch housing.

Moreover, it is likely that coolant spillage under the coolant tank would have been cleaned and dried using compressed air as prescribed by Operation & maintenance Manual OM-02-01 Annex 6. Compressed air could have forced fluid remaining captured by some engine reinforcement fins to enter the clutch housing.

Note: the maximum air pressure available in the maintenance organization was around 7 bars, which is under the 8 bars prescribed by Operation & maintenance.

The figure 15 shows the engine behavior when full throttle was applied the first time after the coolant replacement. This graph shows an overspeed up to 4300 RPM.
Therefore, it is likely that a contamination by coolant liquid occurred during the coolant replacement performed in April 2012.

**Gear box oil contamination**

TAE investigation of both the clutch and the gear box determined that the oil contamination on the internal side of the gear box (Figure 23) resulted from a damaged sealing ring of the driven shaft by debris originating from the slipping friction disk. This oil contamination was thus the consequence of the clutch failure.

TAE found also a sign of oil contamination inside the top of the gear box housing, down to the oil filler plug. However this contamination was very limited and the only traces of contamination found on the rear side of the flywheel were dry (Not oily). It is therefore unlikely that the clutch was contaminated by oil.

**A fuel leakage from the injector drain.**

Could be excluded. The drain line was found in correct position as per Operation & Maintenance Manual TAE 125-01 OM-02-01 Annex 20 entitled “Checking the position of the cylinder head drain hose”.

### 2.6 Comparison between the old and the new style flywheel.

![New style flywheel](image1)

![Old style flywheel](image2)

Figure 24: On the left the new style flywheel and on the right the old style (both pictures show the rear side of the flywheels).

As seen on the above pictures, the new style flywheel features multiple opening which are directly exposed to possible fluid contamination coming from the clutch housing opening. Contamination of both the clutch disk and pressure plates is more likely to occur in case of fluid projections coming from the non-fluid tight opening of the clutch housing.

By contrast, the old style plain flywheel mitigates possible clutch disk and plates contaminations coming from the clutch housing opening.
3 Conclusions.

3.1 Findings.
- The airplane was in airworthy condition, which means properly certified, registered, maintained following an approved maintenance program and duly released to service after maintenance etc.
- The instructor pilot and the student pilot were qualified for the flight.
- The engine #2 loss power soon after the take-off, around 70 seconds after applying full power.
- The engine #2 clutch was found entirely warn out by slipping and destroyed by subsequent overheating.
- Fluid contamination traces were found inside the clutch housing and on the rear side of the flywheel as well as on the internal side of the gear box.
- The engine clutch showed a first sign of degradation (overspeed very limited in time) during the engine test performed after the last maintenance.
- The “ECU warning” system did not activated either during the engine test performed after the last maintenance and during the two next flights.

3.2 Causes.
The probable cause of the engine #2 failure is a contamination of the engine clutch by coolant spillage during the last maintenance operation. The contamination could penetrate in the clutch housing through an opening located under the coolant tank that was only closed by a not fluid-tight plastic cover.

Contributing factors:
- The FADEC warning system was unable to detect preliminary signs of clutch slipping on time.
- The new style clutch, featuring multiple openings in the flywheel, is more sensitive to contamination coming from the clutch housing opening than the old style plain flywheel.
4 Safety recommendations.

On 18 June 2012, TAE released the Service Bulletin TM TAE 000-0007 Rev. 18 entitled “Variant and Software Versions” further to a fatal accident that occurred in Germany with a Diamond DA 42 and a TAE engine.

On 03 July 2012 this Service Bulletin was made compulsory by EASA AD 2012-0116 entitled “FADEC Software – Modification” (see enclosed copy at the end of this report).

The purpose of both the SB and the AD was to improve the software mapping to detect overspeed events and trigger the indication of a permanent ECU caution at an earlier stage.

The inability of the FADEC warning system to detect preliminary signs of clutch slipping on time is therefore considered by AAIU(Be) as being satisfactory solved.

4.1 Recommendation 2012-P-13 to TAE concerning possible penetration of contaminants in the clutch housing.

On 11 May 2012, AAIU(Be) recommended TAE to improve the configuration of the plastic cover of the clutch housing in order to avoid the possible penetration of contaminants in the clutch housing.
Action: On 08 August 2012, TAE published the Service Bulletin TM TAE 125-0022, Rev. 0 entitled “Sealing the crankcase Assembly Opening” (See enclosed copy at the end of this report).
Status: Accepted and closed

4.2 Recommendation 2012-P-16 to TAE concerning possible contamination of the clutch when cleaning the engine.

On 11 May 2012, AAIU(Be) recommended TAE to improve the Operation & Maintenance Manual TAE 125-01 OM-02-01 Annex 6 entitled “Cleaning the Engine” in order to take necessary precaution in order to avoid contamination of the clutch when cleaning the engine.
Status: Accepted and closed

4.3 Recommendation 2012-P-15 to EASA concerning Service Bulletin TM TAE 125-0022, Rev. 0
AAIU(be) recommends EASA to publish an Airworthiness Directive rendering mandatory the application of Service Bulletin TM TAE 125-0022, Rev. 0 entitled “Sealing the crankcase Assembly Opening”.

18 March 2013
5 Enclosures

5.1 AD No.: 2012-0116

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<th>AIRWORTHINESS DIRECTIVE</th>
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<td>AD No.: 2012-0116</td>
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<tr>
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<td>Date: 03 July 2012</td>
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Note: This Airworthiness Directive (AD) is issued by EASA, acting in accordance with Regulation (EC) No 216/2008 on behalf of the European Community, its Member States and of the European third countries that participate in the activities of EASA under Article 66 of that Regulation.

This AD is issued in accordance with EC 1702/2003, Part 21.A.38. In accordance with EC 2042/2003 Annex I, Part M.3.51, the continuing airworthiness of an aircraft shall be ensured by accomplishing any applicable ADs. Consequently, no person may operate an aircraft to which an AD applies, except in accordance with the requirements of that AD, unless otherwise specified by the Agency (EC 2042/2003 Annex I, Part M.3.51) or agreed with the Authority of the State of Registry (EC 216/2008, Article 14(4) exemption).

Design Approval Holder’s Name: Thielert Aircraft Engines GmbH

Type/Model designation(s): TAE 125 engines

TCDS Number: EASA E.055

Foreign AD: Not applicable

Supersede: This AD supersedes EASA AD 2010-0137 dated 30 June 2010.

ATA 73: Engine Fuel & Control – Full-Authority Digital Engine Control (FADEC) Software – Modification

Manufacturer(s): Thielert Aircraft Engines GmbH (TAE)

Applicability:
TAE 125-01 (commercial designation Centurion 1.7), TAE 125-02-99 (commercial designation Centurion 2.0S) and TAE 125-02-114 (commercial designation Centurion 2.0S) engines, all serial numbers.

These engines are known to be installed on, but not limited to, the following aeroplane types, mostly through application of a Supplemental Type Certificate (STC):
- Cessna 172 and (Reims-built) F172 series (STC EASA.A.S.01527),
- Piper PA-28 series (STC EASA A.S.01632),
- CEA PR (APEX, Robin) DR 400 series (STC EASA A.S.01380), and
- Diamond DA 40 and DA 42 series.

Reason:
EASA have received reports of possible power loss on aeroplanes equipped with TAE 125 engines. The preliminary investigation results have shown that an undetected engine overspeed, due to a slipping clutch, may have contributed to these occurrences, in combination with other circumstances.

To prevent flights with a deteriorating clutch, TAE have improved the software mapping to detect overspeed events and trigger the indication of a permanent electronic control unit (ECU) caution at an earlier stage when significant engine power is still available.

For the reasons described above, this AD requires the installation of the improved software mapping version, as applicable to engine Model.

Effective Date: 10 July 2012
### Required Action(s) and Compliance Time(s):

Required as indicated, unless accomplished previously:

- Within 55 flight hours, or within 3 months, or during the next scheduled engine maintenance, whichever occurs first after the effective date of this AD, modify the engine FADEC installation by installing the improved software version 202 (TAE 125-01), version 301 (TAE 125-02-09), or version 302 (TAE 125-02-114), as applicable to engine model:
  - For TAE 125-01 engines: in accordance with the instructions of Annex 13 "FADEC Software Updates of the Operation & Maintenance Manual OM-02-01 Issue 3 Revision 16.
  - For TAE 125-02-09 and TAE 125-02-114 engines: in accordance with the instructions of Annex 17 "FADEC Software Updates of the Operation & Maintenance Manual OM-02-02 Issue 2 Revision 8.

### Ref. Publications:

TAE SB TM [TAE 000-0007 Revision 18](#) dated 18 June 2012.

- Operation & Maintenance Manual OM-02-01 Issue 3 Revision 16 dated 06 May 2012
- Operation & Maintenance Manual OM-02-02 Issue 2 Revision 8 dated 04 May 2012

The use of later approved revisions of these documents is acceptable for compliance with the requirements of this AD.

### Remarks:

1. If requested and appropriately substantiated, EASA can approve Alternative Methods of Compliance for this AD.
2. Based on the required actions and the compliance time, EASA have decided to issue a Final AD with Request for Comments, postponing the public consultation process until after publication.
3. Enquiries regarding this AD should be referred to the Safety Information Section, Executive Directorate, EASA. E-mail: ADs@easa.europa.eu
4. For any question concerning the technical content of the requirements in this AD, please contact:
   Thielert Aircraft Engines GmbH
   Platanenstraße 14
   D-94960 Lichtenstein, Germany
   Telephone +49-37204-696-0; Fax +49-37204-696-55;
   E-mail info@centurion-engines.com
### Technische Mitteilung / Service Bulletin

**Betreff:** Abdichtung der Montageöffnung des Zylinderkurbelgehäuses  
**Subject:** Sealing the Crankcase Assembly Opening

**Betroffenes Luftfahrtgerät:** TAE 125-01  
**Type affected:** TAE 125-01

**Betroffene Geräte-Nr.:** Alle  
**Models affected:** All

**Einstufung:** Kategorie 1 – Sicherheit  
**Compliance:** Category 1 – safety

**Dringlichkeit:** Maßnahmen sind innerhalb der nächsten 100 Flugstunden oder mit der nächsten Wartung durchzuführen, maßgebend ist das ersteintreffende Ereignis.  
**Accomplishment:** Measures have to accomplish within the next 100 flight hours or with the next maintenance, whichever occurs first.

**Grund:** Mögliche Beschädigung der Kupplung aufgrund von Kontamination durch die Montageöffnung des Kurbelgehäuses.  
**Reason:** Possible clutch malfunction due to a contamination via the crankcase assembly opening.

**Maßnahmen:**

1. Den Starter gemäß dem aktuellen Reparaturhandbuch RM-02-0 Kapitel 16.0 demontieren.  
   ■ **ACHTUNG:** Einen adäquaten Reiniger (z.B. Bremsenreiniger) nur in Verbindung mit einem Tuch verwenden!  
   Keinen Reiniger direkt auf das Kurbelgehäuse auftragen, da die Kupplung kontaminiert und dadurch beschädigt werden könnte!

3. Die Bedienungsanleitung auf der Flasche des Dichtmittels sorgfältig befolgen.

---

**Checked:**  
C. Rudolph, CVE  
**Approved:**  
D. Hartung / Office of Airworthiness

---

**Ersetzt Technische Mitteilung Nr. / Datum:** -  
**Replaces Service Bulletin No. / Date:** -
Thielert Aircraft Engines GmbH
Platanenstrasse 14
09350 Lichtenstein, Germany

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Technische Mitteilung / Service Bulletin

Technische Mitteilung Nr. / Datum:
Service Bulletin No. / Date
TM TAE 125-0021, Rev. 0 / 08.08.2012
TM TAE 125-0021, Rev. 0 / August 08, 2012


■ ACHTUNG: Sicherheitshinweise des Dichtmittelherstellers müssen beachtet werden!

♦ Hinweis: Die Montageflächen des Starters müssen sauber bleiben, damit der Starter wieder problemlos montiert werden kann.

5. Das Dichtmittel mind. 8 Std. aushärten lassen bevor Arbeitsabschnitt 6 ausgeführt wird. Siehe Tabelle.

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<thead>
<tr>
<th>Application time (hours)</th>
<th>Tack free time (hours)</th>
<th>Cure time to 35 A Durometer (hours)</th>
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<td>&gt;8</td>
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<tr>
<td></td>
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**Measures:**

1. Remove the starter in accordance to chapter 16.0 of the current Repair Manual RM-02-01.
2. Clean the surface of the crankcase and of the metal plate or plastic plate. The surfaces must be free of grease. See Fig. 1.

■ CAUTION: Use an appropriate cleaner (e.g. brake cleaner) only in combination with a paper towel! Do not apply the cleaner directly to the crankcase, because of possible clutch contamination followed by a potential malfunction!

3. Follow the instructions on the sealant bottle carefully.
4. Seal the assembly opening with the sealant. Make sure that the assembly opening is completely sealed. See Fig. 2 and Fig. 3.

■ CAUTION: The safety instructions of the sealant manufacturer must be observed!

♦ Note: The mounting surface of the starter must remain clean to ensure a installation of the starter without any difficulties.

5. Allow the sealant cure at least 8h before proceeding to step #6. See table.

<table>
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<tr>
<th>Application time (hours)</th>
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<td>24</td>
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</tbody>
</table>

6. Install the starter in accordance to chapter 16.0 of the current Repair Manual RM-02-01.
Technische Mitteilung / Service Bulletin

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Technische Mitteilung Nr. / Datum: TM TAE 125-0021, Rev. 0 / 08.08.2012
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Bild 1 – Reinigung der Montageöffnung / Fig. 1 – Clean the assembly opening

Bild 2 – Abgedichtete Montageöffnung / Fig. 2 – Sealed assembly opening

Hinweise:
Arbeitsaufwand:
2,5 Std., plus Aushärtzeit des Dichtmittels

Remarks:
Labor Effort:
2.5 h, plus cure time of the sealant
### Technische Mitteilung / Service Bulletin

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**Parts:**

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**Zulassung:** Die technischen Informationen, die in diesem Dokument enthalten sind, wurden im Rahmen der Befugnisse der EASA- Genehmigung als Entwicklungsbetrieb Nr. EASA.21J.010 genehmigt.

**Approval:** The technical information contained in this document have been approved under the authority of EASA Design Organisation Approval no. EASA.21J.010.
5.3 Cleaning the engine

Annex 6 Cleaning the Engine

The engine must be cleaned with care. If leakage points are found, their positions must be clearly identified before they are cleaned. The engine must be cleaned only when it is cooled down. Generally, the use of cold cleaners is recommended (e.g. Eylert cleaner, Eylert P/N 89226).

- **CAUTION:** Do not use any cleaners in the area of the clutch. Cleaners can damage the clutch!

- **CAUTION:** The use of easily flammable and caustic cleaning agents is not allowed. Also, avoid cleaning the engine's electrical system, as this may be damaged. The use of high-pressure cleaning equipment is not allowed.

The engine must be dried after cleaning, ideally with compressed air (≤8 bar).