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Study

Events Associated with an Engine Malfunction

Thielert TAE 125 Engines

BEA
Bureau d'Enquêtes et d'Analyses
pour la sécurité de l'aviation civile
Ministère de l'Ecologie, du Développement durable et de l'Energie

Safety Investigations

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SPECIAL FOREWORD TO ENGLISH EDITION

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.

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Glossary

AAIB	Air Accidents Investigation Branch
AD	Airworthiness Directive
AMC	Acceptable Means of Compliance
BEA	Bureau d'Enquêtes and d'Analyses pour la sécurité de l'aviation civile (French Safety Investigation Authority)
CRI	Certification Review Item
CS	Certification Specifications
DECU	Digital Engine Control Unit
EASA	European Aviation Safety Agency
ECU	Engine Control Unit
ENAC	École Nationale de l'Aviation Civile (French National Civil Aviation School)
EPAG	École de Pilotage Amaury de la Grange (French Flight Training Organisation)
ESMA	Ecole Superieure des Métiers de l'Aéronautique (French Flight Training Organisation)
FAA	Federal Aviation Administration
FADEC	Full Authority Digital Engine Control
ft	Feet
IFR	Instrument Flight Rules
IFSD	In-Flight Shut Down
IMC	Instrument Meteorological Conditions
JAR	Joint Aviation Requirements
LBA	Luftfahrt-Bundesamt (German Civil Aviation Authority)
OEB	Operational Evaluation Board
P/N	Part Number
SHK	Statens Haverikommission (Swedish Safety Investigation Authority)
SB	Service Bulletin
SIB	Safety Information Bulletin
TAE	Thielert Aircraft Engines
TBO	Time Between Overhaul
VMC	Visual Meteorological Conditions
VFR	Visual Flight Rules

STUDY CONTEXT

Since 2003, events relating to powerplant malfunctions on aircraft equipped with Thielert engines have frequently been notified to the BEA. By the end of August 2011, 44 had been the subject of a BEA investigation.

In 2005, the BEA recommended to the European Aviation Safety Agency (EASA) that the Thielert TAE 125-01 engine certification be reviewed. This recommendation gave rise to several actions by EASA and Thielert regarding maintenance, operational documentation and training maintenance personnel and in relation to the design of one part. However, although EASA classified its answer as "agreement", no certification review action was undertaken.

New events have occurred since 2004. Most of these notifications came from flying schools. Not all the events notified required investigation. Nevertheless, the considerable number of notifications bears witness to operators' specific concerns about these engines. Some training organisations decided in particular to apply usage restrictions (no night flights or IFR in IMC in single-engine aircraft, no solo flights on DA40).

Given the number of notifications, the recurrence of specific malfunctions and the technological novelty of these engines, the BEA decided in 2009 to conduct this study, the aim of which was to establish if a new request for review of the engine certification was justified or not and if safety recommendations were required.

To do this, the BEA invited the following flying schools to take part in the study and to notify events according to predefined criteria. These schools operate numerous aeroplanes equipped with Thielert engines:

- ENAC: Ecole Nationale de l'Aviation Civile (French National Civil Aviation School);
- EPAG: Ecole de Pilotage Amaury de la Grange (French Flight Training Organisation);
- ESMA: Ecole Supérieure des Métiers de l'Aéronautique (French Flight Training Organisation).

This study is based on the investigations conducted by the BEA on malfunctions to Thielert engines during the period under consideration.

1 – PRESENTATION

1.1 Brief Description of TAE 125 Thielert Engines

TAE 125 engines are inline 4-cylinder diesel engines that were developed based on automotive engines, with modifications to lower the compression ratio. They use high pressure direct injection (common rail fuel injection system) and are turbocharged. For use in aviation, Thielert developed a new engine control system, a propeller reduction gearbox including a torsion damper (or clutch), a new engine mount system and other aircraft specific accessory parts.

Initially Thielert purchased complete engines directly from the production line of the automotive manufacturer. Later, Thielert was able to obtain the parts required separately. The TAE 125-02 engine models use a Thielert-designed aluminium crankcase to avoid weight increase (the baseline engine has a cast iron crankcase). Some parts from the automotive baseline engine are still used. The engine electronic control system and gear box including clutch are similar to those on the TAE 125-01 engine model.

On an aeroplane, propulsion is ensured by a variable pitch propeller driven by the reduction gearbox. The engine and the propeller pitch are fully controlled by a computer (Full Authority Digital Engine Control, FADEC), which simplifies its use: in the cockpit, the pilot inputs a power rating via a single lever. FADEC, which integrates the measurements of various sensors, manages the quantity of fuel injected and propeller pitch in order to obtain the power requested.

These engines are installed, according to the variants, on Diamond DA40 and DA42 aeroplanes, Cessna 172, Piper PA28 and Robin DR400.

Thielert obtained type certificates for two engine types: TAE 125 and Centurion 4.

No malfunctions on the Centurion 4 having been reported to the BEA, this study deals with TAE 125 engines only.

This series includes three variants:

- The TAE 125-01:
  - LBA certification obtained in May 2002, transferred to EASA in March 2006; FAA certification in October 2003,
  - Trade name Centurion 1.7,
  - Engine capacity of 1.7 l;
- The TAE 125-02-99:
  - EASA certification obtained in August 2006, FAA certification in October 2006,
  - Trade name Centurion 2.0,
  - Engine capacity increased to 2 l compared to TAE 125-01;
- The TAE 125-02-114:
  - EASA and FAA certifications obtained in March 2007,
  - Trade name Centurion 2.0s,
  - Engine capacity of 2 l, but power increased compared to TAE 125-02-99.

No malfunctions on this last variant have been notified to the BEA.

TAE 125-01 engines are no longer produced by Thielert. They have been gradually replaced by TAE 125-02-99 engines when they reach the end of their service life.

1.2 Operation of Thielert Engines

In France, Thielert engines mainly equip Diamond DA40 and DA42 aeroplanes, used mainly by flying schools. These aeroplanes are used for VFR, IFR and night flying training.

Aircraft equipped with Thielert engines were very successful with operators, including flying schools. These engines allow the use of JET A1 and have low fuel consumption. The operating cost is therefore lower than with traditional engines.

Reporting figures relating to running hours to the manufacturer and aviation authority is not mandatory in general aviation. Based on information obtained from some users, the manufacturer Thielert estimated the running hours of the totality of its engines at the end of February 2012 as follows:

- TAE 125-01 engines: about 1,390,000 accumulated running hours;
- TAE 125-02-99 engines: about 1,593,000 accumulated running hours.

For information, the hours of operation were requested from the three training organisations that participated in this study. They operated almost half of the DA40D and DA42 equipped with Thielert engines registered in France[1]. At the beginning of December 2011, the running hours declared by these organisations came to:

- TAE 125-01: about 42,500 accumulated running hours;
- TAE 125-02-99: about 92,000 accumulated running hours.

[1] Early December 2011, 71 DA40D and 31 DA42 were registered in France.

1.3 Investigations Conducted by the BEA

Between 2003 and the end of August 2011, the BEA launched 44 investigations into events relating to Thielert engine failures.

Among them are:

- 9 accidents including:
  - 2 dual control instruction flights;
  - 3 solo instruction flights;
- 35 incidents (including one listed as a serious incident) including:
  - 15 dual control instruction flights;
  - 7 solo instruction flights.

The 9 accidents caused 2 serious injuries and 1 slight injury. One accident occurred during a night flight.

27 events involved the TAE 125-01 engine.

17 events involved the TAE 125-02-99 engine.

In the context of the current study, 22 events associated either with a recurring failure, or with performing an emergency landing, were taken into account. They were covered according to subject:

- clutches: 7 investigations;
- low pressure fuel pumps: 3 investigations[2];
- high pressure fuel pumps: 4 investigations;
- electrical failures: 8 investigations.

The list of the 44 events can be found in Appendix 1.

[2] Since the end of August 2011, the BEA has initiated 11 additional investigations on low pressure fuel pump failures.

2 - STUDY OF A SELECTION OF EVENTS

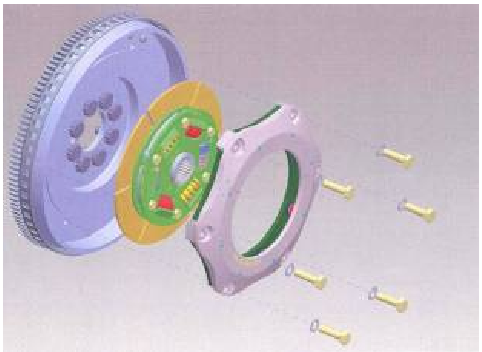
2.1 Clutch

Several clutch failures occurred, for a variety of reasons. The following events occurred due to one of these failures:

- F-GUVH on 01/06/2005;
- F-GUVN on 29/08/2005;
- F-GUVX on 28/01/2008;
- F-HDAU on 21/02/2008;
- D-EAGB on 12/05/2008;
- F-GUVC on 23/06/2009;
- F-HCPM on 18/05/2010.

2.1.1 Description

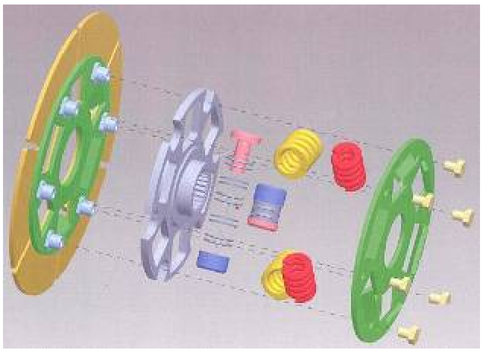
The table below describes the operation of clutches reference (P/N) 05-7211-K006002.



In addition to transmitting motion to the propeller, the role of the clutch system is to damp jolts associated with the operation of the engine:

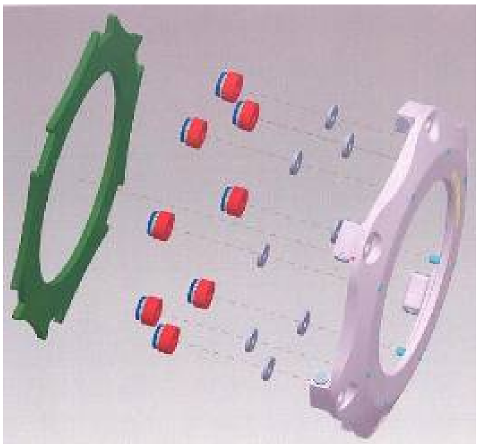
- by sliding (at start-up and shutdown);
- by absorption (during operation) using springs and assemblies of Belleville washers.

It operates on the same principle as an automobile clutch.



Clutch friction disk:

The disk drives the propeller via the reducing gears to which it is linked via a splined shaft.
A preload is applied on the 4 springs. Two stacks of washers (in grey in the diagram) enable this preload to be adjusted. This pre-adjustment is carried out in the factory and cannot be modified by the user.



Clutch cage:

The cage is driven by the engine (it is fitted to the engine flywheel).
Made of 2 parts, this cage compresses the disk, the propeller is then driven.
The cage is screwed to the engine flywheel obeying a nominal tightening value. Eight washer stacks (in red in the diagram) enable this tightening to be adjusted, which is carried out in the factory and cannot be modified by the user.

At the end of their service life the clutches are removed and sent to Thielert for overhaul.

Clutch design and service life has changed since the entry into service of the TAE 125-02-99 engine. In particular, several modifications were made to washer stacks and springs. A new model, with a service life of 600 h, has been in service since the beginning of 2011. Following a design fault, the friction disk (P/N 05-7211-K010201) of this new model was modified (new P/N 05-7211-K012301). The installation of this new model was made mandatory by an EASA AD(3). It operates on the same principle as that described earlier, but has 4 double-coiled spring housings instead of 6 housings for washer stacks and single-coil springs.

(3)EASA Airworthiness Directive 2011-0087-E, referring to Thielert SB TM TAE 125-1013 P1.

2.1.2 Managing the loss of propeller drive

The speed of propeller rotation, indicated on the cockpit instrument panel, is calculated by applying a coefficient equivalent to the engine/propeller reduction rate, to the speed of rotation measured at the crankshaft. The power display is calculated by the FADEC from the fuel outflow rate.

In the event of loss of propeller drive, its rotation speed decreases and the engine speed increases, up to a certain limit. Initially, the pilot notices on his instruments, therefore, an indication of propeller overspeed, which in reality is an indication of engine overspeed. The FADEC then reduces the fuel outflow rate to adjust engine speed. The pilot then observes a drop in power which corresponds to the adjustment carried out by the FADEC.

2.1.3 Events Investigated

❒ **F-GUVH on 01/06/2005**

Examination of the clutch (P/N 02-7210-11001R11) highlighted advanced wear of the disk which led to its slipping in the cage. The propeller was then no longer driven by the engine.

This problem had been observed on several overhauled clutches. The first elements of the investigation led Thielert to issue SB TM TAE 125-0011 to replace all the overhauled clutches in service with new clutches. It decided to limit the service life of clutches to 300 running hours (instead of 800 hours initially).

❒ **F-GUVN on 29/08/2005**

Failure of the clutch (P/N 02-7210-11001R11) occurred at the splined shaft, which broke suddenly with torsion overload, leading to the loss of propeller drive.

Other similar cases led Thielert to:

- review shaft characteristics, adding a thermo-chemical nitriding treatment;
- modify the maintenance manual;
- systematically send a new shaft with each overhauled clutch and gearbox.

❒ **F-GUVX on 28/01/2008, F-HDAU on 21/02/2008 and D-EAGB on 12/05/2008**

For these events, involving TAE 125-02-99 engines, the following were observed:

- either fractures of the clutch Belleville washers (F-HDAU and D-EAGB);
- or a fracture of a clutch spring (F-GUVX).

These fractures led to the clutch (P/N 05-7211-K000304) slipping and loss of propeller drive.

These three incidents, as well as several other events that occurred in Malaysia, led to the issue of the SB TM TAE 125-1006 P1 revision 1, made mandatory by the issue of EASA 2008-0106-E Emergency Airworthiness Directive, requiring that these clutches be replaced by a new model (P/N 05-7211-K006001 or 05-7211-K006002), deriving from the one installed on the TAE 125-01 engine.

❒ **F-GUVC on 23/06/2009 and F-HCPM on 18/05/2010**

In these two cases, clutch (P/N 05-7211-K006002) failure was located at the splined hub. F-GUVC and F-HCPM clutch hubs showed the same damage:

- principal fractures, around the splined part, causing loss of liaison between the engine and the propeller;
- dents in the spring and washer stack housings.

The two hubs broke under a process of fatigue cracking while the clutch had not reached the end of its service life. The fractures and damage observed could be attributed to jolts caused by the engine. For comparison, a hub that had reached the end of its 300 hours life was inspected; the damage observed on the F-GUVC and F-HCPM hubs was not recorded.

2.1.4 Partial conclusion

Clutch failures occurring up until 2008 were solved by the engine manufacturer by issuing service bulletins, recommending the replacement of certain parts, if not a complete change of the clutch.

A technical solution to the problem of fatigue fractures of F-GUVC and F-HCPM (P/N 05-7211-K006002) clutch hubs was not found, however. Since the beginning of 2011, a new clutch model is in service. No failures of this type have occurred on this model.

2.2 Fuel Pumps

2.2.1 Low pressure fuel pumps

Several low pressure fuel pump failures occurred, for a variety of reasons. The following events occurred due to one of these failures:

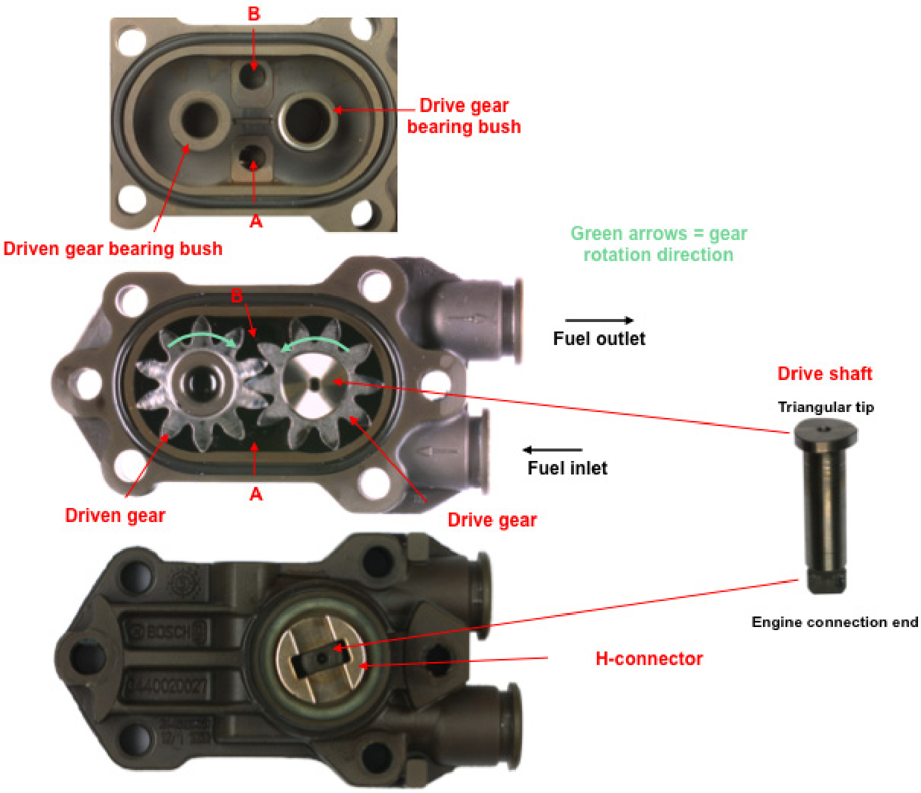
❒ F-GUVM on 16/06/2005;
❒ F-HDAQ on 09/10/2009;
❒ F-HDAP on 27/10/2010.

Description

The first pumps came directly from the automobile manufacturer, and were used without modifications. Following several events, including the one that occurred to F-GUVM, Thielert reduced the pump service life and then modified the drive shaft and the driving gear. The new model's service life is identical to that of the TAE 125-01 engine.

It is a mechanical geared pump, comprising a housing and two straight-toothed gears. The driving gear is linked in rotation to the drive shaft via castellations or a triangular tip depending on different versions. The drive shaft is driven by the engine, via an H-connector among others located outside the pump housing.

The fuel enters through feed inlet A, fills the tooth gaps and is thus conveyed, in the direction of the green arrows, towards discharge outlet B. Suction is created by the void caused when the teeth uncouple.



Events investigated

❒ **F-GUVM on 16/06/2005**

Pump failure was caused by the loss of rotational linking between the drive shaft and the driving gear. In this version of the pump, rotational linking is carried out by castellation. The shaft castellation, with sharp edges, wore down via friction the raised surface on the pump meant to receive the driving gear. This premature wear then generated play leading to wear on the shaft and driving gear castellation.

Comparative examinations showed that these phenomena could recur. The engine manufacturer then modified the pump design, machining the driving gear after reception of the pumps and designing a new drive shaft. The service life of these shafts was initially defined as 300 hours.

❒ **F-HDAQ on 09/10/2009 and F-HDAP on 27/10/2010**

For these two events, pump failure was caused by the fracture of the driving gear. This fracture caused the drive shaft to block. The instant stopping of the shaft, while the connector was still driven, resulted in the sudden fracture of the H-connector and then engine shutdown.

No foreign body was found in the pump housing. Fuel analyses of the F-HDAP showed no anomaly in fuel composition.

At the time of writing this study, additional investigations associated with a failure of the low pressure fuel pump were in progress. Various factors are currently being studied (fuel examinations, metallurgical examinations etc.). The origin of these failures has not yet been determined. They will be the subject of a specific report.

2.2.2 High pressure fuel pumps

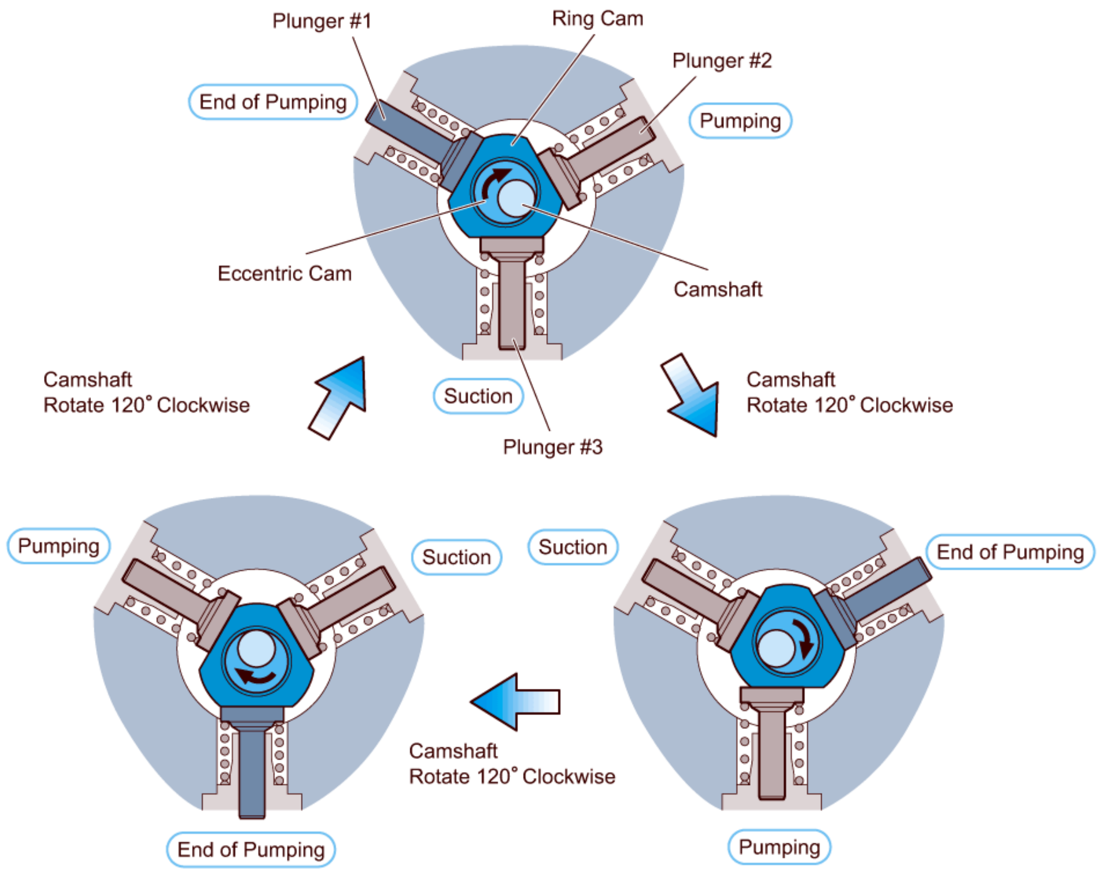
Several high pressure fuel pump failures occurred, for a variety of reasons. The following events occurred due to one of these failures:

- F-GUVK on 11/10/2004;
- F-HDAA on 9/03/2007;
- F-HDAR on 19/03/2010;
- F-HDAP on 06/04/2010.

Description

The pump is supplied with the engine. Thielert keeps the original pump housing and designs and manufactures the other constituent components. Once assembled, the pump is initially installed on the engine by Thielert.

This is a three radial piston type pump, lubricated by fuel. It is driven by the engine using an eccentric camshaft. A triangular cam (ring cam on the scheme below, also called "polygon") comes into contact with the eccentric section via a bush. In normal operation, each flat side of the polygon is in contact with a piston: it is the camshaft's eccentricity that generates polygon movement and therefore compression of the pistons one by one.



Events investigated

The events that occurred to F-HDAA and F-HDAP came from isolated installation or manufacturing defects at the engine manufacturer. They have not been expanded on here.

❐ **F-GUVK on 11/10/2004**

Failure of the high pressure pump resulted from an installation defect: the three holding screws attaching the pump to the engine were unscrewed since they were not safetied in compliance with the original recommended installation.

Following this event, the manufacturer modified the installation procedure for all high pressure pump models: SB TAE 125-0009, revision 1 on 29 October 2004, repeated by AD EASA 2004-10850 on 4 November 2004.

❐ **F-HDAR on 19/03/2010**

Pump blockage was due to friction welding of the eccentric camshaft, the ring and the polygon. The origin of this welding has not been determined.

Possible contributing factors have been identified in the bibliography: pollution of the fuel system, polluted filter, water in the fuel (which causes corrosion of the pump), unsuitable lubricating capacity of the fuel, quality of surface treatment (playing a role in resistance to wear and friction).

The damage observed on the pump seemed similar to that described in the Finnish report (OH-CAU, 28/09/2007) which gave rise to three recommendations to EASA.

Various bibliographical sources(4) agree on the importance of fuel quality as this plays the role of pump lubricant. Use of inappropriate fuel, of additives, or the presence of contaminants (water or others) in the tank may lead to pump failure.

2.2.3 Conclusion

Investigations into the failure of low pressure pumps highlighted several similarities(5).

Analysis of bibliographical references(6) and similar events enabled possible contributing factors to be identified in the failure of this type of low pressure pump:

- ❐ fuel pollution;
- ❐ pump unsuited to kerosene (less lubricating than diesel);
- ❐ design: wrong sized pump for use in aviation;
- ❐ modification: wrongly sized pump, following Thielert machining specific parts of the original pump;
- ❐ use: configuration of the flight acting on fuel supply.

The failures of high pressure fuel pumps were all different cases. Three of them followed an installation or manufacturing error.

The failure of the F-HDAR on 19 March 2010 has not been solved. The bibliography shows the importance of the role of fuel in the smooth running of this type of pump.

Note: At the time of writing this study, several investigations were still in progress. The exact origins of the failures and their technical solutions were still to be determined. A dedicated report will be published.

2.3 Electrical Failures

Control of fuel pressure in the engine rail fuel injection system is directly linked to the position of the single lever. This pressure is exclusively managed by FADEC via measurements carried out by the various sensors installed on the aeroplane. FADEC checks the regulation components. A defect in the measurement series or regulation may have direct consequences on the operation of fuel control and therefore the pressure of fuel allowed in the engine rail fuel injection system.

(4)Bibliographical research carried out on radial piston pumps (operating mode, frequently encountered wear, failure modes, etc) whatever their application (aviation or automobile).

(5)Except for the F-GUVM incident.

(6)Gearing failures, *Fluides et transmissions* Journal n°99, April 2007

Among the events noted during the study, various different cases of electrical failures were identified, particularly during the following events:

- F-GUVB on 25/06/2007;
- N315DR on 06/12/2007;
- F-HDIC on 14/02/2009;
- F-HCMB on 11/03/2009;
- D-GLBA on 23/08/2009;
- F-HDAZ on 17/09/2009;
- F-HCTE on 17/02/2010;
- F-GUVQ on 26/06/2011.

2.3.1 Electrical failures following an improper maintenance operation

Associated events: F-HDIC and F-GUVQ

These two failures were associated with a maintenance error during installation of a connector.

Following an EASA Airworthiness Directive(7), a new connector for the fuel pressure control electro-valve in the rail fuel injection system was installed, requiring wiring modification. Wires were deteriorated or crimped incorrectly during this operation.

(7)The directive makes the application of a service bulletin mandatory for the replacement of the rail pressure control valve (or Prail valve).

A power outage to the electro-valve ensued which, no longer powered, opened. Fuel pressure in the rail fuel injection system almost disappeared, leading to loss of engine power.

2.3.2 Electrical failures linked to a mechanical design fault

Associated events: F-GUVB, N315DR, F-HCMB, D-GLBA, F-HDAZ

These cases of abnormal variation in propeller rotation speed were directly linked to failure of the propeller control valve (or Prop control valve). On a twin-engine aeroplane, these failures may lead to feathering while the engine is running. On a single-engine, the propeller may be brought back to full fine pitch. A design fault was brought to light with an internal coil(8). A coil in the propeller control valve produces a magnetic field that controls the position of the valve piston. Pressure in the propeller governor is controlled by this piston. The wire making up the coil may break following vibrations that occur during flights. Given that the coil was encased in plastic, there could be no cold effect if both sections of the wire were still in contact. When the temperature increased in normal use, the plastic expanded and could separate both sections of the wire. The magnetic field controlling the position of the piston then disappeared and the pressure in the propeller governor dropped.

(8)See the report on the incident to F-HDAZ on 17 September 2009 available at http://eccairs.bea.aero/.

A Service Bulletin was issued by the engine manufacturer to replace this valve with a new model and install a clutch support. Since this issue, no similar event has been notified to the BEA.

2.3.3 Failure to Update Software

Associated event: F-HCTE

FADEC ensures in particular the control of fuel flow rate and monitoring engine operation. It is made of two channels. In the event of failure of one of these channels, the secondary becomes main ("master" channel). The sensors used are either shared by both channels (for example measuring fuel pressure in the common rail), or specific to each channel (for example measuring air pressure allowed in the cylinders).

Measurements carried out by each of these channels were compared in order to detect possible variations and operating defects.

The loss of power that occurred to DA42 F-HCTE on 17 February 2010 was due to an air intake pressure measuring pipe of channel B of FADEC (inactive in normal operation) being pierced. The investigation showed that the detection of a measuring variation between the sensors of each of the channels led to the transfer of authority from channel A to channel B. As the defect came from channel B, FADEC continued operating with the faulty sensor.

A software update had been issued to remedy this defect.

2.3.4 Conclusion

Nearly all the electrical failures observed have been corrected by the manufacturer.

Nevertheless, investigations showed that the strength of the whole system of electronic regulation of the engine directly determined its smooth operation. Some maintenance errors on the fuel pressure regulation system led to the sudden impossibility of maintaining level flight.

However, the investigation on the incident to the DA40D registered F-GUVQ[9] showed that some improvements could be made to the fuel pressure regulation chain and to the relevant maintenance procedures. Following this investigation, the BEA issued in July 2012 the following two recommendations specific to the fuel pressure regulation system:

- *EASA require that Thielert improves the electrical part of the fuel pressure regulation system on TAE 125 engines, in such a way as to make it less vulnerable to power outages; [Recommendation FRAN-2012-057]*
- *EASA require that Thielert develops specific checks following operations on the fuel pressure regulation system, in order to detect possible failures. [Recommendation FRAN-2012-058]*

[9] The English version of the report is available at www.bea.aero/docspa/2011/f-vq110626.en/pdf/f-vq110626.en.pdf.

3 - SAFETY RECOMMENDATIONS ISSUED

Various Safety Recommendations relating to the Thielert engine or its installation on aircraft have been issued over the past few years by the BEA and its foreign counterparts. These recommendations have been listed by the BEA, from the available data on the EASA website[10].

In total, 21 safety recommendations were addressed to EASA:

- 7 involve a design modification or a certification review;
- 6 involve the certification process and particularly regulations CS-23 and CS-E;
- 2 involve continuing airworthiness carried out by Thielert and EASA;
- 2 involve the use of JET A1;
- 4 involve maintenance documentation and associated inspections.

The following table is a summary of these recommendations and responses to them (full details figure in Appendix 2).

Eleven recommendations were accepted, totally or partially, by EASA, including five which were associated with the issue of an Airworthiness Directive. Five were not accepted. Five are currently under consideration.

(10) https://www.easa.europa.eu/safety-and-research/safety-recommendations.php.

Aeroplane	Date	Type of occurrence	State of occurrence	Event	Contents of recommendation	Response
Diamond DA40D **G-HASO**	29 June 2004	Accident	United Kingdom	Damage to turbocharger compressor blades by an unidentified foreign body, scavenge pump seized, overheating and engine shut down. Report available on AAIB website: http://www.aaib.gov.uk	Modify the design of the TAE 125-01 engine lubrication system.	Recommendations delegated to the LBA – **disagreement.** A similar new event having occurred, in 2007 EASA published an airworthiness directive to make Thielert's solution mandatory: **agreement**.
Diamond DA40D **SE-LTF**	15 February 2005	Accident	Sweden	Clutch slipped, loss of propeller drive, emergency landing. Manufacturing defect identified + weaknesses in the clutch and installation documentation. Report available on SHK website: www.havkom.se.	Correct weaknesses in the design and installation documentation for the clutch.	Letter: EASA carried out a review of the TAE 125-01 engine and approved an AD(11)
Diamond DA40D **F-HABJ**	29 October 2005	Accident	France	Fracture of a pushrod, engine shutdown. Eleventh event associated with a problem on a Thielert engine that occurred in France, failures with various origins. Letter of recommendation available on BEA website: www.bea.aero/recos/reco20051124.pdf	Review engine certification urgently, determine as a safeguard the limitations and conditions of use of the DA40D, if necessary reinforce the requirements relating to engine servicing.	**Agreement** – 5 improvements were made in the maintenance and operational documentation, and maintenance personnel training fields and concerning the design of a part.
Diamond DA42 **D-GOAL**	4 March 2007	Accident	Germany	Shutdown of both engines after takeoff.	Make sure that the total failure of the electrical system and the shutdown of DA42 engines are avoided in the event of temporary electrical disconnection. Suspension DA42s until modifications implemented.	**Partial agreement** – 2 ADs(12) issued to make the technical solutions proposed by the aeroplane and engine manufacturers mandatory.

(11) LBA AD D-2005-229R1 referring to Thielert SB TM TAE 125-0011.

(12) EASA AD 2007-0182 referring to revised Thielert installation manual and EASA AD 2007-0183 referring to Diamond SB MSB-42-042 and to revised Thielert installation manual.

Diamond DA40D **OY-RBB**	7 June 2007	Incident	Denmark	Pressure drop in the common rail, engine shutdown. Probable power outage of the fuel pressure regulation valve in the intake rail. Report available on Danish safety investigation authority website: www.havarikommissionen.dk	Review the TAE 125-01 engine design insisting on the fail-safe principle, for individual components as well as powerplant globally, including electrical failure modes.	**Recommendation under consideration**
Diamond DA42 **OE-FCL**	20 July 2007	Accident	Austria	Engine shutdown after takeoff, attempt to restart engine, impossible to feather the propeller.	1. Modify regulations CS-23 and CS-E in order to consider engine failures as major events.	**Disagreement** – no economic/safety element supporting the recommendation.
					2. Analyse the AMC, CRI and special conditions globally during aircraft certification, in order to assess their possible impact on the whole aircraft.	**Agreement -** but EASA believes that the current regulation already covers the problem.
					3. Review certification regulations to improve twin-engine features certified according to the CS-23, so that pilots can handle an engine failure in a safer way (e.g. improved controllability, increased performance reserves).	**Partial agreement-** EASA has modification plans for the regulation relating to pilot licences– it believes that these modifications should solve the problem.
					4. Amend CS-E so that the smooth running of the whole system is demonstrated, in final configuration of installation, during a considerable period of the TBO planned, without significant engine failure or mechanical defect before first delivery to the customer.	**Recommendation under consideration** This recommendation should be dealt with in the context of drawing up the “initial maintenance inspection” regulation.

					5. Absence of redundancy and increase in the number of critical components leads to an increase in the possibilities of engine failure. Take appropriate measures to ensure that the presumed probabilities of failure of a powerplant are followed.	**Disagreement** – the engine shutdown rate is already much lower than the general rate for piston engines.
					6. For aircraft certified according to CS-23, only use components which meet aviation standards (such as cables, connectors etc.) for systems whose failure is critical, unless equivalent qualifications have been demonstrated during certification.	**Partial agreement** - for non-aviation components suitability has to be demonstrated during certification, but aviation parts are not always better per se
Cessna 172N **OH-CAU**	28 September 2007	Accident	Finland	Deterioration of the high pressure fuel pump, fuel pressure control valve blocked in the inlet track in open position, considerable drop in power. Report available on Finnish safety investigation authority website: www.onnettomuustutkinta.fi	1. Take the necessary steps to establish whether JET A1 can be safely used by aircraft fitted with diesel engines, and if so, to what extent.	**Agreement**: JET A1 is suitable. Issue of SIB 2009-02.
					2. Assess the need for a new test for certification of high pressure pumps for TAE engines, using JET A1 which will meet the lowest lubrication values admissible established for jet engine fuel.	**Agreement**: the manufacturer redid tests with fuels with the lowest lubrication known. Design changes carried out during pump examinations.
	11 and 28 September 2007		Germany	Two events of loss of power in flight.	Take the appropriate corrective steps to prevent the reappearance of the unsafe condition.	**Agreement** – AD(13) issued to make the technical solution proposed by Thielert mandatory.
Diamond DA40D **SE-LTF**	7 February 2008	Accident	Sweden	Fracture of the high pressure fuel pump outlet pipe, engine shutdown. Report available on SHK website: www.havkom.se.	Review assessment criteria for airworthiness so that aircraft with known design faults are not authorised to fly.	**Disagreement**: the established rules are appropriate. An AD(14) issued for this specific case of fractures.

(13)EASA AD 2008-0016 referring to Thielert SB TM TAE 125-0017.

(14)EASA Emergency AD 2008-0056R1-E referring to Thielert SB TM TAE 125-1005 P1.

Robin DR400-135 **PH-SVU**	12 July 2008	Serious incident	Netherlands	Abrasion wear of a cable in the fuel pressure control system, power outage to the fuel pressure regulation valve in the intake rail, engine shutdown. Report available on Netherlands safety investigation authority website: http://www.onderzoeksraad.nl	Review TAE 125-01 engine design insisting on the fail-safe principle, for individual components as well as the powerplant as a whole, including electronic failure modes.	**Recommendation under consideration**
Piper PA28-161 Unknown registration	22 August 2009	Incident	Luxembourg	Loss of power due to a failure of piston cooling nozzles. No technical investigation, but in view of the maintenance company's results, Luxembourg Administration issued 3 Safety Recommendations to EASA.	1. Remove the flexible magnet inspection method from the Service Bulletin TM TAE 125-0017.	**Partial agreement:** the service bulletin was revised to further detail the flexible magnet inspection method.
					2. Make another boroscope examination of all TAE 125-01 engines which were inspected by flexible magnet.	**Disagreement:** the number of TAE 125-01 engines is falling as they are being replaced by TAE-02-99. The examination method by flexible magnet, if performed correctly, gives similar results to boroscope examination.
					3. Make an existing design modification for TAE 125-01 engines mandatory.	**Disagreement:** the in service fleet experience does not justify the systematic application of the modification.
Diamond DA40D **F-GUVQ**	26 June 2011	Incident	France	Drop in engine power in cruise, forced landing at an aerodrome. Report available on BEA website: www.bea.aero/docspa/2011/f-vq110626.en/pdf/f-vq110626.en.pdf	1. Require Thielert to improve the electrical part of the fuel pressure regulation system of TAE 125 engines, to make it less vulnerable to power outages.	**Recommendation under consideration**
					2. Require Thielert to develop specific checks after operations on the fuel pressure regulation system, in order to detect possible failures.	**Recommendation under consideration**

4 - ADDITIONAL INFORMATION

4.1 Engine Certification

4.1.1 Background

The European text defining the technical conditions applicable in engine certification is the CS-E (Certification Specifications for Engines).

The CS-E does not propose classification of the effects of failures that could affect piston engines. It does not, therefore, propose maximum occurrence rates of failures.

4.1.2 Certification of Thielert engines

The TAE 125-01 engine was certified based on technical conditions defined by JAR-E, change 10. TAE 125-02-99 and 125-02-114 engines were certified based on technical conditions defined by the CS-E in the 23 September 2003 version.

The bases for certification of the TAE 125-02-99 engine are set out in the CRI-A1. As TAE 125 engines were initially engines bought from the production line of the automobile manufacturer, Thielert did not have access to the specifications of all the constituent elements of the engine. Nor did it control modifications which could be introduced by the automobile manufacturer. Consequently, several compensating factors were put in place by the primary certification authority (LBA then EASA) in order to overcome the impossibility for Thielert of showing compliance with specific technical requirements of the JAR-E and then of CS-E.

In order to establish a certain level of confidence in these compensating factors, EASA required Thielert to inform it of:

- any inflight engine shutdown;
- any unscheduled removal of the engine;
- any unexpected loss of power or propeller pitch control;
- any engine fire;
- any defect that could lead to a dangerous situation for safety.

In addition, the primary certification authority prescribed a special condition relating to the failure analysis of each of the engine variants. For the TAE 125-02-99 engine, this special condition was the subject of the CRI-T2 and provided classification of failures and malfunctions on the operation of the engine. Malfunctions leading to a total or partial loss of power (described as "safe engine shutdowns") were classified as "minor[15]".

[15] For instance, a malfunction leading to an uncontrollable fire is classified as "dangerous".

4.2 Certification and Operation of Light Aircraft

The European text defining the technical conditions applicable in aeroplane certification in normal, utility, aerobatic and commuter categories is the CS-23.

Sub-section E of the CS-23 defines the technical conditions applicable for certification of the powerplant on these aircraft. This sub-section does not define additional technical conditions for the powerplant in the event of the use of the aeroplane in IFR or in VFR at night. It does not require analysis of powerplant malfunctions.

In France, the decree of 24 July 1991 concerning conditions of use of civil aircraft in general aviation defines in particular the minimum equipment required in IFR and in night VFR. These lists of minimum equipment do not include any item specific to the powerplant.

A proposal for regulation on aviation operations, including in particular in appendix the NCO (Non-Commercial Operations, a section concerning the use of non-complex aircraft[16] in non-commercial use) section is currently before the European Commission. The proposed text, available on the EASA website, does not define any item specific to the powerplant in the lists of minimum equipment for operating in IFR or in night VFR.

In general aviation, reporting on running hours may, as is the case in France, not be mandatory. No occurrence rate can therefore be associated with the various categories of malfunction.

4.3 Continuing Airworthiness

Continuing airworthiness is based mainly on assessing the critical nature of occurrences. It is carried out by the holder of the type certificate and the Authority in accordance to the principles established in section A of Part 21 of Commission Regulation (EC) N°1702/2003 of 24 September 2003 laying down implementing rules for the airworthiness and environmental certification of aircraft and related products, parts and appliances, as well as for the certification of design and production organisations.

4.3.1 Notification of events

Article 21A.3 of Part 21 stipulates that the holder of a type certificate:

- *"shall have a system for collecting, investigating and analysing reports of and information related to failures, malfunctions, defects or other occurrences which cause or might cause adverse effects on the continuing airworthiness of the product, part or appliance covered by the type-certificate […].*
- *shall report to the Agency any failure, malfunction, defect or other occurrence of which it is aware related to a product, part, or appliance covered by the type-certificate, restricted type-certificate, supplemental type-certificate, ETSO authorisation, major repair design approval or any other relevant approval deemed to have been issued under this Regulation, and which has resulted in or may result in an unsafe condition. "*

This article also specifies that:

- *"These reports shall be made in a form and manner established by the Agency, as soon as practicable and in any case dispatched not later than 72 hours after the identification of the possible unsafe condition, unless exceptional circumstances prevent this.*
- *When an occurrence […] results from a deficiency in the design […], the holder of the type-certificate […] shall investigate the reason for the deficiency and report to the Agency the results of its investigation and any action it is taking or proposes to take to correct that deficiency."*

The definition of a condition that could compromise safety (unsafe condition) is proposed in AMC 21A.3B (b):

" a) An event […] that would result in fatalities, usually with the loss of the aircraft […]
Unless it is shown that the probability of such an event is within the limit defined by the applicable airworthiness requirements[17].
[…]"

[16]The definition of complex aircraft is given by Article 3(j) of Regulation (EC) N°216/2008 of the European Parliament and of the council of 20 February 2008 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency, and repealing Council Directive 91/670/EEC, Regulation (EC) N°1592/2002 and Directive 2004/36/EC.

[17]Certification standards only provide for an occurrence probability limit for aircraft certified. in accordance with CS 25 in AMC 25.1309.

The document specifies that certain repetitive events may be considered unsafe conditions, if they are likely to lead to the consequences described above in certain operational conditions.

Note: Guidance Material 21A.3B (b) provides a methodology and examples to determine if an unsafe condition exists.

When EASA considers that an unsafe condition existed or exists and may recur on another aeroplane, it may issue an Airworthiness Directive.

4.3.2 Estimate of in-flight engine shutdowns

Holders of engine type certificates may provide an estimate of inflight engine shutdown rates. Thielert reports 3 rates to EASA weekly in the framework of continuing airworthiness:

- "basic" in-flight shutdowns[18];
- "basic" in-flight shutdowns + engine in-flight shutdowns whose cause has not yet been identified;
- "basic" in-flight shutdowns + engine in-flight shutdowns whose cause has not yet been identified+ "non-basic[19]" in-flight shutdowns.

The regulatory definition of engine shutdown is given in AMC 20[20], in a paragraph devoted solely to ETOPS flights[21]. This definition is given in Appendix 3.

There is no regulatory requirement on these rates. However, EASA explained that it compared these data with an average rate of piston engine "basic" in-flight shutdowns, estimated by the FAA, of 10 per 100,000 flying hours, in general aviation[22]. For the other rates, there is no such reference.

At the end of February 2012, Thielert estimated that the average rate of "basic" in-flight shutdowns of the TAE 125-01 engine, throughout its period of operation since entry into service, was about 5.9 per 100 000 flying hours. If the three types of engine shutdowns are considered, the rate estimated by Thielert was about 10.3 per 100,000 flying hours.

At the end of February 2012, Thielert estimated that the average rate of "basic" in-flight shutdowns of the TAE 125-02-99 engine, throughout its period of operation since entry into service, was about 4.8 per 100,000 flying hours. If the three types of engine shutdowns are considered, the rate estimated by Thielert was about 8.8 per 100,000 flying hours.

4.4 Operators' Engine Use and Safety Investigations conducted on Incidents

Numerous contacts were made between operators of aeroplanes fitted with Thielert engines and the BEA during the various investigations.

Operators also communicated with each other on the failures encountered. The incidents that occurred in service associated with the engine's novelty led them to exchange information regularly on the subject of failures. They explained that they expected better communication from the manufacturer when failures occurred in service.

[18] Thielert Source: "basic" in-flight shutdowns are engine losses of power of more than 15%, due to failure of an element in the engine type certificate.

[19] Thielert Source: "non-basic" inflight engine shutdowns are engine losses of power of more than 15%, due to an improper act of maintenance or operation of the engine.

[20] General Acceptable Means of Compliance for Airworthiness of Products, Parts and Appliances.

[21] AMC 20-6 rev. 2, Chapter I General Considerations, Section 4 Terminology.

[22] Memorandum of 24 May 1999 from the FAA "Engine and Propeller Standards Staff" office.

Some of them put in place operational restrictions for single-engine flights, following in-service failures, fearing an engine failure which could lead to an accident. These restrictions could be:

- ❒ Prohibition of night flights;
- ❒ Prohibition of IFR flights in IMC;
- ❒ Prohibition of solo flights.

A feeling of lack of communication with Thielert may have contributed to creating disquiet among operators and led them to notify numerous incidents.

Without calling the principle into question, more targeted notifications would undoubtedly have led the BEA to limit the number of investigations and not to investigate incidents solely covered by continuing airworthiness.

5 - ANALYSIS

5.1 Correction of Recorded Failures

The following technical issues were brought to light during thirteen investigations: design faults of different engine components, faults in maintenance procedure or part overhaul processes. In each case, the engine manufacturer introduced a solution: recurring modifications of service life, modification of maintenance procedure or manufacturing processes, design modification. Furthermore, estimates of in-flight shutdown rates established by Thielert proved to be better than those estimated by the FAA, taken as the reference by EASA. Consequently, a review of the engine certification did not seem appropriate.

Specific failures have shown, however, that improvements were necessary. The failures encountered on the fuel control system showed a certain fragility of the latter as any electric power outage led to an almost total loss of power. In addition, the shortcomings in the checks during associated operations made it impossible to detect any errors.

The failures encountered in low pressure fuel pumps have not yet been explained. The BEA, in cooperation with Thielert and specialised laboratories, is continuing the study of various cases of fracture encountered.

5.2 Safety Recommendations Issued

Safety recommendations were issued by several investigation authorities in order to review engine certification, certification of specific engine parts or existing certification rules. By issuing Airworthiness Directives, EASA made mandatory some technical solutions provided by the manufacturer. There were no modifications of the applicable regulation for engine or light aeroplane certification.

These recommendations were issued by various investigation authorities with the aim of preventing the appearance of new failures. They did not constitute a presumption of fault on the part of the manufacturer. The points they have in common suggest that the failures recorded on Thielert engines were representative of deficiencies in certification rules.

5.3 Single-engine Night or IMC Flights

Some training organizations put in place operational restrictions such as prohibition of single-engine night or IMC flight. These restrictions, decided on as a result of technical failures, aim to avoid a catastrophic event in case an engine failure occurs. Among the 9 accidents researched in thus study, only the accident that occurred at night led to the destruction of the airplane; the 8 others occurred in VMC by day.

It appeared that the certification regulations do not provide for additional requirements on the engine or powerplant in case of use, in general aviation, of a single-engine aeroplane in IFR or in night VFR. Yet, in these operating conditions, an engine failure may lead to an accident with catastrophic consequences (unsafe condition). Visibility conditions during these kinds of flights prevent the pilot from making a safe emergency landing. This situation applies to every single-engine airplane certified for IFR or night flight, whatever the engine model.

6 - CONCLUSION AND RECOMMENDATIONS

Note: In accordance with Article 17.3 of European Regulation (EU) 996/2010 of the European Parliament and Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation, a safety recommendation shall in no case create a presumption of blame or liability for an accident, a serious incident or an incident. The addressee of a safety recommendation shall inform the safety investigation authority which issued the recommendation of the actions taken or under consideration, under the conditions described in Article 18 of the aforementioned Regulation.

Many investigations have been initiated by the BEA into events linked to Thielert engines. Several recommendations have been addressed to EASA by various investigation authorities. A certain disquiet as to the use of these engines was noticed by the BEA in flying schools and in flying clubs. Some operators put in place operational restrictions in order to prevent possible accidents. It is impossible to know if these operational restrictions have, in fact, helped to avoid any accidents.

Nevertheless, solutions were introduced by the manufacturer for almost all of the recorded failures. The statistics also indicate that the rate of in-flight shutdowns for Thielert engines is no greater than that of other engines in general aviation.

It is not therefore justified to recommend a review of the certification of Thielert engines.

However, the investigation into the incident to F-GUVQ on 25 April 2010 brought to light a weakness in the design of the fuel pressure regulation system. An electrical power outage can in fact lead to total loss of power. In addition, no specific check of the electrical circuit is scheduled following the associated maintenance operations. Such a check would, however, have made it possible to detect the fault before the loss of power occurred. Two Safety Recommendations were issued in the final report.

The BEA repeats its recommendations:

- ❐ *that EASA require that Thielert improves the electrical part of the fuel pressure regulation system on TAE 125 engines, in such a way as to make them less vulnerable to power outages; [Recommendation FRAN-2012-057]*
- ❐ *that EASA require that Thielert develops specific checks following operations on the fuel pressure regulation system, in order to detect possible failures. [Recommendation FRAN-2012-058]*

The European regulatory definition of in-flight shutdown (AMC 20-6) is not adapted to light aviation. Therefore, comparisons between a reference rate and the different manufacturers' engine shutdown rates seem difficult to establish. Moreover, losses of power that prevent level flight being maintained should systematically be counted, their consequences being similar to those of an engine shutdown.

Consequently, the BEA recommends that:

- ❍ **EASA adopt a definition of engine shutdown for aircraft certified in accordance with CS-23. [Recommendation FRAN-2013-084].**

In France, the majority of events occurred during a flight performed in VMC by day. The pilot was generally able to land in the country or at a nearby aerodrome. However, one accident occurred during a night flight, and other malfunctions may have appeared in IMC, at night or in solo flight, conditions in which the success of an emergency landing is uncertain. Thus the operational consequences of the same powerplant malfunction may vary greatly depending on the flight rules adopted. However, in CS-23, classification of engine failure does not depend on operating conditions.

Consequently, the BEA recommends that:

❍ **EASA define the acceptable occurrence rate for drops in engine power, particularly those that make it impossible to maintain level flight, in order to establish a classification appropriate to operating conditions. [Recommendation FRAN-2013-085].**

List of appendices

Appendix 1
Table of 44 events investigated by the BEA from 2003 to end of August 2011

Key:

- **in bold: event developed in the study**
- *in italics: investigation not closed at time of publication of this study*

Note: the eleven events relating to failure of low pressure fuel pumps occurred after August 2011.

Date	Registration	Aircraft model	Engine type	Type of operation	Description of event	Occurrence category
22/06/2003	F-GNJV	Diamond DA40D	TAE 125-01	Pleasure	Engine failure on initial climb, landing in the country: fuel circuit design fault	Accident
27/12/2003	F-GUVH	Diamond DA40D	TAE 125-01	Dual control instruction	Drop in engine power during aerodrome circuit, missed landing off runway	Accident
11/10/2004	**F-GUVK**	**Diamond DA40D**	**TAE 125-01**	**Dual control instruction**	**Fuel leak, flight abandoned voluntarily, engine shutdown on final: unsuitable assembly of the high pressure fuel pump**	**Incident**
13/11/2004	F-HABN	Diamond DA40D	TAE 125-01	Instruction - solo	Loss of more than 90% power, emergency landing on the runway: cracked crankcase	Incident
17/04/2005	*F-GJMT*	*Diamond DA42*	*2 x TAE 125-01*	*Other*	*"low pressure oil" red light displayed and dual display of orange "ECU" lights: voluntary engine shutdown, diversion: faulty oil pressure information transmission cable*	*Incident*
01/06/2005	**F-GUVH**	**Diamond DA40D**	**TAE 125-01**	**Personal use**	**Drop in engine power on climb, emergency landing at an aerodrome: maintenance programme unsuitable for overhauled clutch**	**Incident**
16/06/2005	**F-GUVM**	**Diamond DA40D**	**TAE 125-01**	**Dual control instruction**	**Engine shutdown on short final, forced landing before the runway, on instruction: failure of the low pressure fuel pump**	**Serious incident**
29/08/2005	**F-GUVN**	**Diamond DA40D**	**TAE 125-01**	**Engine ground run**	**Clutch shaft failure**	**Incident**
29/10/2005	F-HABJ	Diamond DA40D	TAE 125-01	Instruction - solo	Engine shutdown on initial climb, return to base, runway overrun during landing: pushrod broken	Accident
17/11/2005	F-GUVI	Diamond DA40D	TAE 125-01	Dual control instruction	Propeller overspeed, diversion, during night flight: propeller pitch control system oil filter clogging	Incident
16/01/2006	F-HABP	Diamond DA40D	TAE 125-01	Instruction - solo	Drop in engine power on initial climb	Incident
26/01/2006	F-HABM	Diamond DA40D	TAE 125-01	Dual control instruction	Propeller overspeed during climb, drop in engine power, flight aborted	Incident
22/04/2006	F-HABI	Diamond DA40D	TAE 125-01	Instruction - solo	Drop in engine power during climb, display of "ECU A FAIL" and "ECU B FAIL" lights, reverse QFU landing	Incident
28/05/2006	F-BXIT	Cessna F172	TAE 125-01	Personal use	Display of "ECU A FAIL" then "ECU B FAIL" lights on cruise, variations in engine speed, diversion	Incident
09/03/2007	**F-HDAA**	**Diamond DA42**	**2 x TAE 125-01**	**Dual control instruction**	**Fuel leak during climb: filing caught between the high pressure fuel pump seal and the parting line during assembly by the manufacturer**	**Incident**
11/06/2007	F-GUVI	Diamond DA40D	TAE 125-01	Instruction - solo	Drop in engine power during initial climb, flight abandoned: malfunction of injectors connector	Incident
19/06/2007	F-HJPS	Robin DR400	TAE 125-01	Dual control instruction	Drop in engine power, emergency landing on a microlight airfield: design anomaly in the air intake circuit	Incident

Date	Registration	Aircraft model	Engine type	Type of operation	Description of event	Occurrence category
25/06/2007	**F-GUVB**	**Diamond DA40D**	**TAE 125-01**	**Personal use**	**Propeller overspeed on cruise, drop in engine power, diversion: failure of the propeller control valve**	**Incident**
26/06/2007	F-GUVO	Diamond DA40D	TAE 125-01	Instruction - solo	Drop in engine power during base leg	Incident
18/07/2007	F-HDAY	Diamond DA40D	TAE 125-01	Personal use	Drop in engine power, forced landing in a field: turbocharger shaft broken– probable manufacturing failure of axial thrust flange	Accident
06/12/2007	**N315DR**	**Diamond DA42**	**2 x TAE 125-01**	**Other**	**Drop in right engine power in cruise, precautionary landing, right engine shutdown during landing: failure of propeller control valve and rail pressure control valve**	**Incident**
28/01/2008	**F-GUVX**	**Diamond DA40D**	**TAE 125-02-99**	**Instruction - solo**	**Drop in engine power in cruise, emergency landing at destination aerodrome: clutch spring broken**	**Incident**
21/02/2008	**F-HDAU**	**Diamond DA40D**	**TAE 125-02-99**	**Dual control instruction**	**Propeller overspeed, drop in engine power, emergency landing in the country during a night flight: clutch Belleville washers broken**	**Accident**
22/04/2008	F-HABR	Diamond DA40D	TAE 125-02-99	Instruction - solo	Drop in engine power, emergency landing in the country: slackness of the fuel filter output connector	Accident
12/05/2008	**D-EAGB**	**Cessna F172**	**TAE 125-02-99**	**Personal use**	**Engine failure on cruise, forced landing in the country: clutch Belleville washers broken**	**Incident**
14/02/2009	**F-HDIC**	**Diamond DA40D**	**TAE 125-02-99**	**Instruction - solo**	**Loss of power on cruise, emergency landing in the country: incorrect crimping of fuel pressure control valve connector**	**Accident**
11/03/2009	**F-HCMB**	**Diamond DA40D**	**TAE 125-01**	**Dual control instruction**	**Propeller overspeed, diversion: failure of the propeller control valve**	**Incident**
23/06/2009	**F-GUVC**	**Diamond DA40D**	**TAE 125-02-99**	**Personal use**	**Engine failure in cruise, forced landing on an aerodrome: clutch hub broken**	**Incident**
23/08/2009	**D-GLBA**	**Diamond DA42**	**2 x TAE 125-01**	**Personal use**	**Hard landing after a single engine approach after the right engine shut down: failure of the propeller control valve and unintentional handling of the left engine throttle lever on final**	**Accident**
17/09/2009	**F-HDAZ**	**Diamond DA40D**	**TAE 125-02-99**	**Dual control instruction**	**Variations in engine power in cruise, diversion: failure of propeller control valve**	**Incident**
09/10/2009	**F-HDAQ**	**Diamond DA42**	**2 x TAE 125-02-99**	**Dual control instruction**	**Left engine shutdown after landing: low pressure fuel pump drive broken**	**Incident**
17/02/2010	**F-HCTE**	**Diamond DA42**	**2 x TAE 125-02-99**	**Ferry flight**	**Drop in engine power in cruise, diversion: failure of the air inlet pressure pipe and use of an obsolete software version on the FADEC**	**Incident**
04/03/2010	F-HABI	Diamond DA40D	TAE 125-02-99	Instruction - solo	Drop in engine power during approach, forced landing in the country	Incident
11/03/2010	F-GNAZ	Cessna F172	TAE 125-01	Personal use	Drop in engine power during the approach, forced landing in the country: probable presence of air in the fuel system	Accident

Date	Registration	Aircraft model	Engine type	Type of operation	Description of event	Occurrence category
18/03/2010	F-HCMG	Diamond DA40D	TAE 125-01	Dual control instruction	Variations in propeller speed during the approach: probable failure of the propeller control valve connector	Incident
19/03/2010	**F-HDAR**	**Diamond DA42**	**2 x TAE 125-02-99**	**Dual control instruction**	**Complete loss of power on one engine during initial climb, return to departure aerodrome: failure of the high pressure fuel pump**	**Incident**
06/04/2010	**F-HDAP**	**Diamond DA42**	**2 x TAE 125-02-99**	**Engine ground run**	**Failure of the high pressure fuel pump after 5 hours of operation: manufacturing defect of a pump part**	**Incident**
25/04/2010	F-GUVH	Diamond DA40D	TAE 125-01	Dual control instruction	Engine overspeed and multiple warnings triggered on initial climb	Incident
18/05/2010	**F-HCPM**	**Robin DR400**	**TAE 125-02-99**	**Personal use**	**Engine failure in cruise, forced landing in the country: clutch hub broken**	**Incident**
01/06/2010	F-HCAN	Diamond DA42	2 x TAE 125-02-99	Personal use	False fire alarm on one engine, precautionary landing on one engine	Incident
27/10/2010	**F-HDAP**	**Diamond DA42**	**2 x TAE 125-02-99**	**Dual control instruction**	**Engine shutdown in cruise: low pressure fuel pump drive broken**	**Incident**
16/12/2010	F-HCMB	Diamond DA40D	TAE 125-01	Dual control instruction	Variations in power during manoeuvres, precautionary landing: probable wear on propeller control valve connector	Incident
11/05/2011	*F-GOKD*	*Diamond DA42*	*2 x TAE 125-02-99*	*Dual control instruction*	*A friction disk element broke in flight, triggering a warning, precautionary landing*	*Incident*
26/06/2011	**F-GUVQ**	**Diamond DA40D**	**TAE 125-02-99**	**Personal use**	**Failure of the Prail valve connector, loss of power on cruise, forced landing at aerodrome**	**Incident**

Appendix 2
Safety recommendations issued and responses from EASA

Accident to G-HASO on 29 April 2004

Synopsis of the event: The aircraft's engine failed in flight when most of the oil was lost overboard. From an altitude of 2.000 ft the pilot carried out a successful forced landing into a field. The engine's turbocharger compressor had been damaged resulting in an imbalance that caused vibration. This vibration induced a fatigue failure of a bearing and a piece of this bearing passed into the oil scavenge pump, causing it to seize. With the pump seized, the oil separator overfilled causing the engine oil to escape via the breather vent line. This caused a loss of oil that resulted in the engine overheating and then seizing.

Safety Recommendation UNKG-2005-048: The EASA should consider requiring Thielert Aircraft Engines to modify its TAE-125 diesel engine's oil system to reduce the likelihood of sections from a failed turbocharger causing seizure of the oil scavenge pump.

Reply: As a further incident happened within similar circumstances EASA issued the AD 2007-0232 on 23 August 2007 which refers to the Thielert Service Bulletin TM TAE 125-0016, initial issue dated 19 September 2006 and Revision 1 dated 15 June 2007.

Category: Agreement - Status: Closed

Extract from 2008 Annual Safety Recommendations Review (EASA document)

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RÉPUBLIQUE FRANÇAISE
Ministère des Transports,
de l'Equipement,
du Tourisme et de la Mer

COPIE

Le Bourget, le 24 NOV. 2005

BEA
Bureau d'Enquêtes et d'Analyses

Monsieur le Directeur Exécutif
Agence Européenne de la Sécurité Aérienne
Postfach 10 12 53
D-50452 Cologne
Allemagne

Copie à Monsieur le Directeur du
Contrôle de la Sécurité
Direction Générale de l'Aviation Civile
50, rue Henry Farman
75720 Paris Cedex 15

N° 007004 /BEA/D

Objet : recommandation de sécurité

Monsieur le Directeur,

Le 29 octobre 2005, le DIAMOND AIRCRAFT DA40 immatriculé F-HABJ, équipé d'un moteur THIELERT TAE125, effectuait un atterrissage forcé consécutif à un arrêt du moteur, alors qu'il venait de décoller de l'aérodrome de Castelnaudary.

L'examen préliminaire du moteur a révélé une rupture mécanique de la bielle du cylindre n°1. Des analyses et examens complémentaires sont en cours afin de déterminer plus précisément les raisons de cette défaillance.

Ces travaux ont permis de mettre également en évidence une usure anormale et prématurée de la pompe basse pression carburant. L'usure constatée sur les pignons de cette pompe à engrenages présente de nombreuses similitudes avec les dommages constatés sur celle du DIAMOND AIRCRAFT DA40 immatriculé F-GUVM. Ce dernier, également équipé du moteur THIELERT TAE125, avait effectué un atterrissage d'urgence suite à une perte de puissance en finale, le 16 juin 2005, à proximité de l'aérodrome de Montpellier. Cette défaillance était directement attribuable à une détérioration des pignons de cette pompe.

Au total, trois accidents, un incident grave et sept incidents relatifs à des défaillances moteurs ont été notifiés au BEA en à peine plus de deux ans. Outre les ruptures identifiées ci-dessus, les origines de ces défaillances sont diverses : ruptures mécaniques prématurées de

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European Aviation Safety Agency

Safety Recommendation Reply

Recommendation issued on 24/11/2005

Subject:	Accident to Diamond DA-40, Thielert TAE125 registered F-HABJ on 29/10/2005 in Castelnaudary airfield.
Safety recommendation:	Le BEA recommande que l'AESA entreprenne de facon urgente une revue de certification du moteur THIELERT TAE125 et, à titre conservatoire, détermine les limitations des conditions d'utilisation de l'avion DIAMOND AIRCRAFT DA40 et si nécessaire, renforce les exigences relatives à l'entretien du moteur.
Response category:	Agreement.
Response:	A certification review has lead to the following improvements : - action 1: EASA AD 2006-0044 issued on 15 February 2006 requires the exchange of the low pressure fuel pump to be incorporated in the Maintenance Manual and mandatory every 300h. - action 2: TAE has increased the number of Maintenance Trainings Seminars - action 3: TAE implemented a note in all new Pilot Operating Handbook supplement revisions that in the case of overspeed, the airspeed must be reduced and that climbing remain possible at 65 KIAS. - action 4: TAE introduced a note in the engine operation and maintenance manual. Diamond can amend its Pilot Operating Handbooks. - action 5: To our knowledge, all clutch shafts above 300h have been exchanged. Magnetic Particle Inspection on all returned shafts showed no signs of crack. The three recorded failures seems to be related to a particular production batch. However, in between all parts are nitrided which also improves the material stress resistance not only against bending load but also against torsional load.
Status:	Closed.

Accident to SE-LTF on 15 February 2005

Recommendation: *"It is recommended that the Civil Aviation Authority and EASA take action to correct the above-mentioned weaknesses in the design and the installation documents of the clutch (RL 2006:08 R1)."*

European Aviation Safety Agency

Dr. Norbert Lohl • Certification Director

EASA (2005) CDIR/NLO/51034

Mr. D. Akerman
Swedish Accident Investigation Board
P O. Box 12538
SE-102 29 Stockholm
SWEDEN

Cologne, 14 December 2005

Subject: Thielert TAE 125 engine – Accident with Aircraft SE-LTF

Your ref : L-03/05 SE-LTF

Dear Mr. Akerman,

First, we would like to thank you for the submittal of your investigation report L-03/05 SE-LTF on 12 Dec. 2005.

Please be informed that EASA is currently undertaking a review of the Thielert TAE 125-01 engine.
Apart from a review of the specific design features of the clutch we will take special care of the assembly and maintenance procedures and related potential deficiencies as outlined in your report.

It is our understanding that the Thielert company has already addressed one potential driving factor for clutch slipping with the publication of Service Bulletin TAE 125-0011, which was also made mandatory by an EASA approved Airworthiness Directive.
After our review this may be completed by additional instructions for assembly and maintenance.

Our Propulsion Section will keep you informed about progress of the review.

Yours sincerely,

N. LOHL

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Accident to D-GOAL on 4 March 2007

Synopsis of the event: On 4 March 2007 a DA 42 suffered a total electrical power loss immediately after take-off during the retraction of the landing gear- As result, both engines failed. During the emergency landing on the runways extended centre line, the airplane was severely damaged.

Safety Recommendation GERF-2007-004: EASA should ensure that failure of the entire aircraft electrical system and both engines because of temporary voltage interruptions in the aircraft type DA 42 with electrically controlled engines is effectively prevented. Until the modifications are implemented, these aircrafts should not be operated.

Reply: The EASA has addressed this issue by issuing Airworthiness Directives 2007-0182 and 2007-0183 on 02.07.2007, mandating technical solutions proposed by the aircraft and the engine manufacturer.

Airworthiness directive 2007-182, regarding TAE125-01 and TAE125-02-99 engines installed in Diamond DA42 aircraft, requires the inspection of the engine installation to verify conformity to the instructions contained in the Engine Installation Manuals IM-02-01 or IM-02-02, dealing with the electrical system and the FADEC, as revised by the engine manufacturer following this event.

Airworthiness directive 2007-0183 mandates the modification of the electrical system of the DA 42 aircraft, by the installation of additional Engine Control Unit backup batteries, in accordance with the aircraft manufacturer's Mandatory Service Bulletin 42-042 and Work Instruction WI-MSB-42-042, issued in June 2007. It also mandates the amendment to the DA 42 Aircraft Maintenance Manual made by the aircraft manufacturer after this event, and the update of the operators maintenance programme. Finally, it mandates the amendment to the DA42 Airplane Flight Manual, introduced by the aircraft manufacturer following the event.

Category: Partial Agreement - Status: Closed

Extract from 2008 Annual Safety Recommendations Review (EASA document)

Accident to OY-RBB on 7 June 2007

Synopsis of the event: During a training flight the instructor and student pilot practised an emergency landing exercise. During reduction of the engine power, both engine control system warning lights started to flash, and the engine stopped. Subsequently the instructor took over control of the aircraft and executed an emergency landing on a meadow. The aircraft was seriously damaged however the occupants suffered no injuries.

Safety Recommendation NETH-2011-014: The European Aviation Safety Agency (EASA) is recommended to revise the certification requirements for the TAE-125-01 diesel engine design, with the emphasis being put on the fail-safe principle being applied to an individual engine component, as well as to the complete power plant system including its electronic failure mode.

Reply: EASA acknowledges receipt of this Safety Recommendation. Please be advised that it is under consideration and that the outcome will be communicated to you in due course.

Category: Unknown - Status: Open

Extract from 2011 Annual Safety Recommendations Review (EASA document)

Accident to OE-FCL on 20 July 2007

Synopsis of the event: Der Pilot führte mit einem Passagier vom FlughafenLinz zum Flugplatz Krems/Gneixendorf mit dem gegenständlichen Luftfahrzeug einen Privatflug durch. Beim Rückflug nach Linz fiel nach dem Start das rechte Triebwerk aus, worauf der rechte Propeller in Segelstellung wechselte. Der Pilot wollte jedoch den Flug zum Zielflugplatz fortsetzen. Da er Probleme bekam, den ausfallsbedingten Momentenausgleich zu bewerkstelligen und Flughöhe verlor, versuchte er das rechte Triebwerk wieder zustarten, was jedoch misslang. Der rechte Propeller befand sich nunmehr nicht mehr in Segelstellung, wodurch das Luftfahrzeug stärker an Flughöhe verlor. Der Pilot entschloss sich nahe St.Pantaleon/NÖ zu einer Notlandung. Im Endanflug bemerkte er eine etwa quer zur Anflugrichtung verlaufende Stromleitung, die er versuchte zu unterfliegen. Nach dem Aufsetzen überschlug sich das Luftfahrzeug. Der Pilot wurde schwer, seine Passagierin leicht verletzt. Das Luftfahrzeug wurde zerstört.

❒ Recommendation 1

Safety Recommendation AUST-2009-008: Festlegung von Triebwerksausfällen als Major Event im Rahmen der Zertifizierung von Luftfahrzeugen bzw. Triebwerken nach den Certification Specifications 23 (CS-23) bzw. Certification Specifications Engines (CS-E):Derzeit werden im Rahmen von Zertifizierungen von Luftfahrzeugen nachden CS-23 bzw. den CS-E Triebwerksausfälle als Minor Event eingestuft. Für ein- und zweimotorige Luftfahrzeuge, die nach den CS-23 zertifiziert sind, stellt jedoch ein Triebwerksausfall eine schwere Störung mit hohem Gefährdungspotential dar (z.B. mehrere Unfälle der DA 42 nach Ausfall eines einzelnen Triebwerkes). Im Rahmen von Zertifizierungen von Luftfahrzeugen bzw. Triebwerken nach den CS-23 bzw. CS-E sollten Triebwerksausfälle als Major Event gewertet werden.

Reply: Certification Specifications (CS) 23 for Normal, Utility, Aerobatic and Commuter Aeroplanes and CS-E for Engines do not take a probabilistic approach to piston engine failure. Reference to minor and major severity classifications for piston engine failures are therefore inappropriate for this class of aircraft. For piston engines, CS-E.210 requires that a failure analysis be performed to establish that no single fault could lead to unsafe engine conditions beyond the normal control of the flight crew. While no specific reliability target is given, state-of-the-art engines typically achieve loss of power rates of between 10-3 and 10-5/ flight hour. Aircraft are certificated on the basis of assured continued safe flight or landing following engine failure. In effect, CS-23 mitigates the consequence of engine failure, for instance by controlling stalling speed (Vso) and structural crashworthiness for single engine aircraft, or by requiring investigation of handling qualities and performance of multiple engine aeroplanes with a failed engine. However, it cannot be excluded that, under some conditions, the effects of engine partial or complete loss of power at aircraft level remain more severe than minor or even major, but the overall safety objectives can still be met considering the reduced exposure time to such conditions. While the Agency will continue to monitor accident/incident trends and related causal factors, there is currently no safety/economic data to support changing airworthiness standards inorder to increase piston engine reliability.

Category: Disagreement - Status: Closed

Extract from 2011 Annual Safety Recommendations Review (EASA document)

❐ Recommendation 2

Safety Recommendation AUST-2009-009: Gesamtanalyse der Auswirkungen der Acceptable Means of Compliance (AMC), der Certification Review Items (CRI) bzw. der Special Conditions im Rahmen von Zertifizierungen von Luftfahrzeugen / Triebwerken / Propeller nach Certification Specifications 23 (CS-23), Certification Specifications Engines (CS-E) bzw. Certification Specifications Propeller (CS-P):

Im Rahmen der Zertifizierungen von Luftfahrzeugen/Triebwerken/Propellern nach CS-23/CS-E/CSP konnen und werden aus verschiedenen Grunden (z.B. weil die CS-23/CS-E/CS-P noch keine Regelungen enthalten, die dem Stand der Technik entsprechen, auf Wunsch des Herstellers o.a.) oft zahlreiche CRI's bzw. Special Conditions festgelegt, die Teil der genehmigten Zertifizierung werden. Auch wenn einzelne AMC's, CRI's bzw. Special Conditions unproblematisch erscheinen, besteht dennoch die Moglichkeit, dass diese im Zusammenwirken mit anderen AMC's, CRI's bzw. Special Conditions im Betrieb des Gesamtluftfahrzeuges zu kritischen Storungen fuhren konnen.

Im Rahmen von Zertifizierungen von Luftfahrzeugen, Triebwerken und Propellern nach CS- 23, CSE beziehungsweise CS-P sollten die AMC's, CRI's und Special Conditions in Bezug auf mogliche Auswirkungen auf das Gesamtluftfahrzeug einer Gesamtanalyse unterzogen werden.

Reply: The Agency agrees with this recommendation but believes that the current regulations are covering this Safety Recommendation. Certification of aviation products is carried out in accordance with Commission Regulation (EC) 1702/2003 and its Annex, Part 21 which details the establishment of certification basis, including Special Conditions (21A.16B). Certification Review Items are part of the certification process and are raised to record the means of compliance to be shown with the appropriate Certification Specifications in cases where direct applicability and compliance is not directly clear and where special conditions, alternative means of compliance or equivalent safety findings are proposed. In addition, guidance material is issued by EASA to assist in this process. The impact of these mechanisms in establishing compliance with the Essential Requirements of Commission Regulation (EC) 216/2008 is subject to an overall analysis in the context of the certification of aircraft, engines and propellers according to the appropriate Certification Specifications. As a result of this a Final Report is issued and the Type Certificate is issued on the basis of the statements of compliance contained therein.

Category: Agreement - Status: Closed

Extract from 2010 Annual Safety Recommendations Review (EASA document)

❒ Recommendation 3

Safety Recommendation AUST-2009-010: Maßnahmen zur Verbesserung der Flugleistung und der Steuerfähigkeit nach Ausfall eines Antriebes bei zweimotorigen, nach den CS-23 zertifizierten Luftfahrzeugen:

Es wurde festgestellt, dass Piloten der DA 42 nach Ausfall eines Triebwerkes Steuerungsprobleme und Probleme hatten, die Flughöhe zu halten.

Im Vergleich zu Verkehrspiloten sind Piloten von Luftfahrzeugen, die nach der CS-23 zugelassen sind, im Regelfall weniger umfangreich ausgebildet,haben weniger Übung und Flugerfahrung und fliegen außerdem im Regelfall als “Single Pilot“.

In den Zulassungsvorschriften sollten geeignete Maßnahmen gesetzt werden, die es Piloten von zweimotorigen, nach den CS-23 zertifizierten Luftfahrzeugen nach Ausfall eines Triebwerkes (vor allem des kritischen Triebwerkes) ermöglichen, der aufgetretenen schweren Störung sicherer zu begegnen (z.B. Verbesserung der Steuerfähigkeit, Erhöhung der vorgeschriebenen Leistungsreserven).

Reply: In the future EASA pilot licensing rules, the type rating requirements for multi-engine aeroplanes are proposed to be the same whatever the licence held by the pilot or the certification standard of the aircraft (refer Notice of Proposed Amendment 2008-17 available on the EASA website).These requirements contain training and testing provisions regarding one engine failures. The Diamond DA 42 has similar capabilities as other Certification Specifications (CS) 23 aircraft. EASA does not intend to differentiate according to the certification standard. However, in December 2010 the Agency conducted an Operational Evaluation Board (OEB) review of the current training practices, specifically the differences training as described in the Joint Aviation Requirement on Flight Crew Licencing (JAR-FCL) 1.235(c)(1). The OEB concluded that difference training courses between Multi-Engine Piston (MEP) variants should be conducted by a Flight Training Organisation (FTO) or Type Rating TrainingOrganisation (TRTO) when the differences between the variants include:

i) Electronic Flight Instrument System (EFIS) displays,
ii) integrated avionics,
iii) single lever engine operation,
iv) other systems as determined by the Authority.
The full details of the OEB evaluation are available at the EASA website.

Category: Partial Agreement - Status: Closed

Extract from 2011 Annual Safety Recommendations Review (EASA document)

❒ Recommendation 4

Safety Recommendation AUST-2009-011: Änderung der Zertifizierungsvorschriften für Kolbentriebwerke CS-E:

Nach der Zertifizierung der DA 40 und DA 42 mit TAETriebwerken Centurion 1,7 und 2,0 sind eine Vielzahl von schweren Störungen und Antriebsausfälle aufgetreten. Die Zertifizierungsvorschriften sollten dahingehend geändert werden, dass vor der ersten Auslieferung an Kunden die Funktion des Gesamtsystems in voll konformer Installation über einen wesentlichen Zeitraum der angestrebten TBO ohne Antriebsausfall oder markantem mechanischen Defekt nachgewiesen wird.

Reply: The Agency has initiated a rulemaking task RMT.0180 (former E.010) 'Initial Maintenance Inspection' to address this issue. The Agency will consider the Safety Recommendation as part of this rulemaking task.

Category: Unknown - Status: Open

Extract from 2011 Annual Safety Recommendations Review (EASA document)

❐ Recommendation 5

Safety Recommendation AUST-2009-012: Ausfallsicherheit von Antrieben mit Kolbentriebwerken:

Nach der Zertifizierung der DA 40 und DA 42 mit TAETriebwerken Centurion 1,7 und 2,0 sind eine Vielzahl von schweren Störungen und Antriebsausfälle aufgetreten. Die vorausgesagte Standfestigkeit hat mit der tatsächlichen bei weitem nicht übereingestimmt. Bei konventionellen Antrieben und Zulassungen war es üblich, bei bekannt ausfallkritischen Teilen wie z.B. der Zündung diese doppelt auszuführen. Dies ist nicht mehr der Fall. Gleichzeitig hat die Anzahl der ausfallkritischen Teile, die sich in modernen Antrieben befinden, zugenommen. Daher führt der Ausfall einzelner Bauteile zu kompletten Triebwerksausfällen. Es sollte geeignete Maßnahmen getroffen werden, die in der Praxis sicherstellen, dass die angenommene Ausfallwahrscheinlichkeit des Einzelantriebes (Einzeltriebwerk incl. allfälliger Getriebe, Kupplungen, Propellerregelungen etc.) gewährleistet ist. Dies sollte u.a. die weitgehend redundante Ausführung von ausfallkritischen Bauteilen (z.B. Elektro - ((z.B. Main Bus System)) und Treibstoffversorgung, Zündung, Propellerregelung etc.) beinhalten.

Reply: It should be noted that all piston engines, conventional as well as non-conventional, have non-redundant components that can cause an engine shut down or power loss (e.g. a failure of a carb float of a conventional spark ignited carburetted piston engine). The engine certification rules have never required redundant fuel systems for piston engines. Therefore there is no significant difference in the fuel system design of conventional and non-conventional piston engines. Because diesel engines are self-igniting, there is no need for an ignition system at all. EASA has reviewed the in-flight shut down/power loss (IFSD) rate of the TAE 125 engines. After implementing of several mandatory corrective actions, the IFSD rate of the TAE 125-01 and TAE 125-02 engines is now well in the expected range for piston engines. The FAA has established the following general event rates for piston engines (see FAA Memorandum 1999-00006):

• Shutdowns/power losses: >1 every 10,000 hours;
• Accidents: 1 every 100,000 hours;
• Fatal Accidents: 1 every 1,000,000 hour.

The actual IFSD of the TAE 125 engines is around 0.4 every 10,000 flight hours (rolling 12 month) which is less than half of the IFSD rate established by the FAA.

Category: Disagreement - Status: Closed

Extract from 2011 Annual Safety Recommendations Review (EASA document)

At the time of publication of this study, the EASA reply to the sixth recommendation in the report on the accident to OE-FCL on 20 July 2007 was not online on the website at http://www.easa.europa.eu/safety-and-research/safety-recommendations.php.

Accident to OH-CAU on 28 September 2007

Synopsis of the event: An air accident occurred at approximately 16:29 on Friday 28 September 2007 at Sipoonlahti, west of the city of Porvoo. A Cessna 172N, registration OH-CAU, made an emergency landing on Porvoo motorway, close to the Sipoonlahti exit. In addition to the pilot there were two passengers onboard. No-one was injured; however, the aircraft sustained major damage. The incident caused no harm to road traffic.

❒ Recommendation 1

Safety Recommendation FINL-2009-001: The investigation commission recommends that the EASA take action to establish whether JET A1 can safely be used as fuel in diesel engine-equipped aircraft, and if it can, the required measures.

Reply: EASA has reviewed the issues related to JET A1 and determined that it can be used safely in diesel-engine powered aircraft. EASA will monitor also possible future changes of JET A1. EASA issued 22 January 2009 the Safety Information Bulletin 2009-02 "Piston Engine Powered Aircraft, operated on Automotive-or Jet Fuel" which is partly addressing this issue.

Category: Agreement - Status: Closed

❒ Recommendation 2

Safety Recommendation FINL-2009-002: The investigation commission recommends that the EASA consider whether a new type certificate test be required for TAE engine high-pressure fuel pumps, using such JET A1 fuel which meets the lowest permissible lubricity value set for jet engine fuel.

Reply: The engine manufacturer has retested the high-pressure fuel pumps with low lubricity test fuels, High Frequency Reciprocating Rig (HFRR) tests, (HFRR >900 \m). Necessary design changes to the high pressure pumps are implemented during the mandatory pump inspections where all pumps are sent back to Thielert for complete inspection. These measures will ensure safe operation in the future. It should be noted that there is no lowest permissible HFRR lubricity value set for jet engine fuels. So testing was done for fuels of the lowest known HFRR lubricity value.

Category: Agreement - Status: Closed

Extract from 2010 Annual Safety Recommendations Review (EASA document)

Recommendation from German Safety Investigation Authority (Bundesstelle für Flugunfalluntersuchung - BfU) linked to 2 inflight loss of power events on 11 and 28 September 2007:

Synopsis of the event: Two occurrences of an Inflight loss of power

Safety Recommendation GERF-2007-010: EASA should establish appropriate corrective measures for the engines already in production and operation to prevent the unsafe condition.

Reply: EASA has in close connection with TAE reviewed and discussed this safety recommendation. As a result of this and some additional testing, TAE issued the Service Bulletin TM TAE 125-0017 on 14 December 2007 which requires an inspection of all affected engines. The EASA has issued Airworthiness Directive No. 2008-0016 in order to mandate this action. Based on the results of this inspection possible further actions will be determined, which we would communicate with you. The EASA believes that these actions adequately address, at this stage, this safety recommendation.

Category: Agreement - Status: Closed

Extract from 2008 Annual Safety Recommendations Review (EASA document)

Accident to SE-LTF on 7 February 2008

Synopsis of the event: The pilot took off from Gothenburg City Airport for a solo navigation exercise to gain a night-time endorsement to his pilot's licence. After about ten minutes of flight the engine stopped. The pilot carried out an emergency landing on the only available lit area, on the E45, which is a four-lane motorway. The right wing struck a lighting column before the aircraft landed on the ground. Immediately after touching down the aircraft collided with a private car. The aircraft then slid off the road and continued along the grass to the left of the road. Another private car was struck by gravel and wreckage parts as the aircraft finally stopped. he pilot was unhurt and could exit the aircraft without assistance. Neither of the car drivers were injured.

Safety Recommendation SWED-2009-015: It is recommended that EASA considers a fresh evaluation of its criteria in assessing airworthiness, so that aircraft with known serious design faults are not permitted to fly.

Reply: A structural or fatigue analysis, various types of risk assessment methodologies such as provided in Part 21 Guidance Material 21A.3(b), or engineering judgment, are routinely used to define acceptable compliance times for the correction of an unsafe condition and provide for acceptable safety levels. The Agency agrees that for the specific issue of the Thielert cracked fuel pipe, corrective action should be taken with a compliance time of "before further flight". This was implemented by EASA through Emergency Airworthiness Directive (EAD) 2008-0056R1-E, as soon as sufficient information was available to justify this decision.

Category: Disagreement - Status: Closed

Extract from 2010 Annual Safety Recommendations Review (EASA document)

Accident to PH-SVU on 12 July 2008

Synopsis of the event: During a training flight the instructor and student pilot practised an emergency landing exercise. During reduction of the engine power, both engine control system warning lights started to flash, and the engine stopped. Subsequently the instructor took over control of the aircraft and executed an emergency landing on a meadow. The aircraft was seriously damaged however the occupants suffered no injuries.

Safety Recommendation NETH-2011-014: The European Aviation Safety Agency (EASA) is recommended to revise the certification requirements for the TAE-125-01 diesel engine design, with the emphasis being put on the fail-safe principle being applied to an individual engine component, as well as to the complete power plant system including its electronic failure mode.

Reply: EASA acknowledges receipt of this Safety Recommendation. Please be advised that it is under consideration and that the outcome will be communicated to you in due course.

Category: Unknown - Status: Open

Extract from 2011 Annual Safety Recommendations Review (EASA document)

Incident in Luxembourg on 22 August 2009

Synopsis of the event: On Tuesday, 22 August 2009, at 18:03 UTC after take-off from ELLX, a Piper PA28-161 aircraft reengined with a Thielert Aircraft Engines TAE 125-01 unit encountered an in-flight power loss which resulted in an emergency off-airport landing on an uphill sloped pasture field. The glider experienced pilot and his passenger were uninjured and the airplane did not sustain any damage resulting from the emergency landing.

❒ Recommendation 1

Safety Recommendation LUXM-2009-001: EASA should request the engine manufacturer to withdraw the inspection method using a flexible magnet from (SB) TM TAE125-0017.

Reply: EASA has reviewed the inspection methods of the Thielert Aircraft Engines (TAE). It was found that both methods can be used but the areas for investigation in the oil sump have to be described more detailed in Service Bulletin (SB) TM TAE 125-0017. TAE revised the SB (Rev. 3 dated 5 March 2010) and extended the instructions for both methods by adding pictures and information about the inner walls of the oil pan.

Category: Partial Agreement - Status: Closed

❒ Recommendation 2

Safety Recommendation LUXM-2009-002: EASA should require all engines inspected with a flexible magnet in accordance with Service Bulletin (SB) TM TAE125-0017 to undergo, as soon as possible, an inspection using a flexible borescope in accordance with SB TM TAE125-0017.

Reply: Due to the declining number of affected engines (because of implanting Thielert Aircraft Engine (TAE) modification No 2007-001 and replacement of TAE 125-01 engines by TAE 125-02-99 engines), the revised instructions and the overall experience from the field, the low likelihood of undetected oil nozzle failure is being reduced further. The flexible magnet method does provide the same results as the borescope method, if carried out properly.

Category: Disagreement - Status: Closed

❒ Recommendation 3

Safety Recommendation LUXM-2009-003: EASA should consider mandating the TAE Design Modification No. 2007-001 for aircraft affected by AD No.: 2008-0016 R1.

Reply: EASA together with Thielert Aircraft Engine (TAE) GmbH has reviewed the issues related to the oil nozzle problem of the TAE 125-01 engines. The in-service experience of the fleet does not concur to warrant the TAE design Modification No 2007-001.

Category: Disagreement - Status: Closed

Extract from 2010 Annual Safety Recommendations Review (EASA document)

Accident to F-GUVQ on 12 July 2008

The investigation showed that in the event of an electrical power cut to the Prail valve, the pressure in the common inlet duct dropped suddenly and the pilot had to make a forced landing. Several events of this type have occurred, and gave rise to safety recommendations. One person was seriously injured. The cutting of the wire on the F-GUVQ probably occurred following a maintenance action in March 2009, however, since this action, no check had enabled the failure to be detected until this event occurred.

The fuel pressure control chain could be improved, without the engine's full certification being reviewed. In fact, the absence of redundancy on this critical system can rapidly lead to an emergency situation. In the same way, for the F-GUVQ and PH-SVU events, specific checks during maintenance servicing would have enabled the detection of the fault on the cable before the event.

This is why the BEA recommends that:

- EASA require that Thielert improves the electrical part of the fuel pressure regulation system on TAE 125 engines, in such a way as to make them less vulnerable to power outages; [Recommendation FRAN-2012-057]
- EASA require that Thielert develops specific checks following operations on the fuel pressure regulation chain, in order to detect possible failures. [Recommendation FRAN-2012-058]

Appendix 3
Definition of Engine In-flight Shutdown given by AMC 20-6

Chapter I: General Considerations

Section 4: Terminology

f. In-flight Shutdown (IFSD)

In-flight shutdown (IFSD) means when an engine ceases to function and is shutdown, whether self-induced, flight crew initiated or caused by an external influence. For ETOPS, all IFSDs occurring from take-off decision speed until touch-down shall be counted.

The Agency considers IFSD for all causes, for example: flameout, internal failure, flight crew initiated shutdown, foreign object ingestion, icing, inability to obtain or control desired thrust or power, and cycling of the start control, however briefly, even if the engine operates normally for the remainder of the flight.

This definition excludes the cessation of the functioning of an engine when immediately followed by an automatic engine relight and when an engine does not achieve desired thrust or power but is not shutdown. These events as well as engine failures occurring before take-off decision speed or after touch-down, although not counted as IFSD, shall be reported to the competent authority in the frame of continued airworthiness for ETOPS.

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