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MINISTÉRIO DA ECONOMIA E DO EMPREGO

GABINETE DE PREVENÇÃO E INVESTIGAÇÃO DE ACIDENTES COM AERONAVES

(GPIAA)

ACCIDENT FINAL REPORT

OO-TML

Aldeia de Sete

CASTRO VERDE

15th of September 2009

GPIAA
Homologo, nos termos do nº 3
do artº 26º do D. L. 318/99,
de 11 de Agosto de 1999

15/09/2011

O Director,

Fernando Ferreira dos Reis

FINAL REPORT № 35/ACCID/2009

Foreword

The present report has been prepared with the sole objective of the accidents prevention.

The safety investigation is a process towards prevention of accidents which has incorporated gathering and analysis of data, determination of the causes and, if appropriate, the issuance of safety recommendations.

In conformity with Annex 13 to the Convention on International Civil Aviation, Chicago 1944, with the Regulation (EU) N.º 996/2010 of the European Parliament and the Council, of 20th October 2010, and with Decree-Law Nº 318/99, of 11 of August, article 11º, n.º 3, the safety investigation does not have the purpose to apportion blame or liability.

1. The accident was reported to GPIAA at 21h15 (standard time)[1] by ANPC.

For the relevant safety investigation, the GPIAA Director has appointed the following Investigation Team composition:

- Investigator-in-charge: Fernando Lourenço
- Safety investigator: António Alves
- Safety investigator: António Barros

GPIAA has notified ICAO, EASA and the State of Registry, State of Design, State of Manufacture and the State of the Accident Victims and their Families, as well.

The Kingdom of Belgium had appointed Mr. Luc Blendeman, Chief Investigator of Air Accidents, as State of Registry Accredited representative.

The United States of America appointed Mr. Aguilera Jason, NTSB Air Safety Investigator, as State of Manufacture and Design Accredited representative.

2. All times in this report are UTC/GMT unless stated otherwise.

3. This report was originally edited in Portuguese language and translated into English. The Portuguese version is considered the official report and it will always prevail in case of any doubt arises.

[1] Standard time is the official Portuguese hour. Standard time = UTC + 1

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Acronyms

AAE	Aeronautical Academy of Évora
AMC	Aeromedical Centre
AGL	Above Ground Level
ANPC	*Autoridade Nacional de Protecção Civil*
AP	Autopilot
ATC	Air Traffic Control
ATPL	Airline Transport Pilot Licence
AVGAS	Aviation Gasoline
BAFA	Belgium Air Flight Academy
BCAA	Belgium Civil Aviation Authority
Cº	Celsius degrees
CPL	Commercial Pilot Licence
CVR	Cockpit Voice Recorder
EASA	European Aviation Safety Agency
ELT	Emergency Locater Transmitter
FAA	Federal Aviation Administration
FD	Flight Director
FDR	Flight Data Recorder
fh	Flight hours
FL	Flight Level
ft	Feet
GNR	*Guarda Nacional Republicana*
GPS	Global Positioning System
GS	Ground Speed
in	Inch
HSI	Horizontal Situation Indicator
ICAO	International Civil Aviation Organization

IFR	Instrument Flight Rules
ILS	Instrument Landing System
IM	*Instituto de Meteorologia, IP*
INAC	*Instituto Nacional de Aviação Civil*
IT	Investigation Team
lbs	Pounds
MHz	Megahertz
MSL	Mean Sea Level
MSSR	Monopulse Secondary Surveillance Radar
MTOM	Maximum Take-Off Mass
NDB	Non-Directional Beacon
NM	Nautical Mile
PI	Instructor Pilot
S	Selective
S/N	Serial Number
T	True
TH	True Heading
UBI	*Universidade da Beira Interior*
USG	United States Gallon
UTC	Coordinated Universal Time
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions
VN	Night flight

Synopsis

On the 15th of September 2009, at 20:54, the PA 34-220T SENECA V aircraft, registration marks OO-TML, with call sign "Diana 11", operated by AAE, was performing a navigation flight when it was submitted to a catastrophic structural failure inflight having crashed on a rural field, near Sete village, in Castro Verde municipality. The flying instructor and the two flight students have perished in the accident. The aircraft has been destroyed due to its breakup inflight and to the impact forces. At the moment of the accident, night flight, visual meteorological conditions prevailed.

The investigation team determined that the probable cause of this accident was an occurrence typified as "*run away trim"*, not adequately resolved, leading to total loss of the aircraft control, consequently exceeding the structural load limits, and resulting in aircraft breakup inflight.

The lack of the pilot instructor's suitable training in recovering from unusual flight attitudes aggravated by the darkness conditions and without external references, it was considered a contributing factor. At the time of the accident the operator did not instruct the recovering from unusual flight attitudes neither by visual references nor instruments, nor this was required by the Civil Aviation National Authority.

The Safety issues analyzed in this report are focused on prevention of loss control of the aircraft and in the training given to pilots concerning unusual attitudes recovery.

During the investigation the AAE was alerted, by IT, to the urgent implementation of unusual attitudes recovery training to their Flying instructors.

Two relevant Safety Recommendations were issued and addressed to INAC.

1. Factual information

1.1 History of the flight

On the 15th of September 2009, at 20:54, the PA 34-220T SENECA V aircraft, registration marks OO-TML, with call sign "Diana 11" operated by AAE, was performing a navigation training night flight when it was subjected to a structural failure inflight having crashed on a rural field, nearby Sete village, within Castro Verde municipality. All the occupants, a Flying instructor and two flight students, onboard have perished in the accident. The aircraft has been destroyed due to its breakup inflight and to the impact forces. At the moment of the accident visual meteorological conditions prevailed.

The flight training plan comprised taking off from Seville (LEZL), climb up to FL 110 towards Faro (LPFR), where an ILS approach would be performed, including one touch and go, followed by climbing up to FL 080 and a final landing on Évora aerodrome (LPEV).

In Seville, the aircraft was refuelled with 61,4 USG of AVGAS.

At 19:50, the aircraft took off from Seville and headed west and climbing to FL 110. The Flying instructor was controlling the aircraft and was sitting on the right hand side seat, and one student pilot was sitting on the left hand side. The student was performing his third flight in multiengine aircraft, within the scope of ATPL (A) rating course. The other student pilot, who had been the pilot flying on previous flight, was onboard as a crewmember.

According to the AAE Training Manual, dated September 01st, 2009, this ATPL (A) training phase should begin with three landing exercises. The third flight exercise was linked to the exercise nº 6. It was supposed to last 01h30 with the following profile: take-off (0º flaps/25º flaps), climb, cruise level, steep turns, approaching stalls, approach for landing, using FD, and final landing. However, the first navigation flight mission was scheduled for the exercise nº. 12 at which time students would have already accumulated about 15 hours of flying experience in this aircraft type.

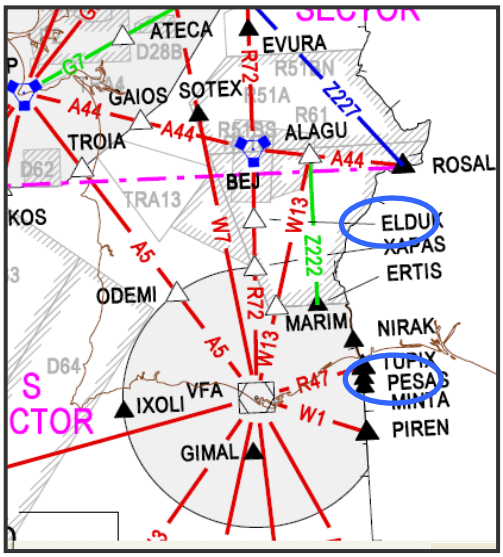


Figure 1

At 20:22:37, Diana 11 crossed Faro Terminal Control Area inbound via MINTA. Communications were then performed by the PI.

At 20:36, the aircraft executed an approach to Faro airport runway 28 proceeding outbound to the right, heading northwards.

At 20:39:52, PI reported altitude 3.000ft.

At 20:44, when it was 16 NM away from Faro, Diana 11 was cleared to climb to FL 080. The PI did read back the clearance correctly (this was his last communication).

At 20:53:06, the aircraft reached FL 080 and it was over XAPAS.

At 20:53:37, Faro ATC approach advised Diana 11 crew to contact Lisbon ATC on the frequency 125.550 MHz.

At 20:53:39, Faro MSSR lost aircraft tracking through Mode C

At 20:53:51, Beja MSSR (with Mode S interrogator code capability) spotted the aircraft at 4.000ft altitude.

From this very moment the aircraft vanished from all MSSR's scopes.

Meanwhile, ATC made several attempts to contact the Diana 11 crew through emergency frequency (121.5 MHz) and relaying with other aircraft flying nearby.

In the coming minutes, the ANPC received several calls from inhabitants of the Castro Verde municipality reporting a possible aircraft crash.

At 21:45, the GNR helped by citizens found the wreckage spread over a large area, a site (N37° 37' 35.00'', W007º 57' 24.14'')[2] with about 750ft altitude MSL, nearby Sete village, 14 km southeast of Castro Verde.

1.2 Injuries to persons

This accident has generated 3 fatal injuries with the following nationalities:

Crew:

One Spanish citizen crew member;

One Dutch citizen crew member;

One crew member[3] with double nationality, namely Australian and Dutch.

Injuries	Crew	Passengers	Others
Fatal	3	–	–
Serious	–	–	–
Minor/None	–	–	

Table 1.

1.3 Damage to aircraft

The aircraft was destroyed.

1.4 Other damage

There was no damage sustained by objects other than the aircraft.

[2] The coordinates are according to DATUM WGS84

[3] Without specific task in this flight leg, flying on the back seats.

1.5 Personnel information

References	Instructor	Student
Identification:		
Gender:	Male	Male
Age:	25	18
Nationality:	Spanish	Dutch
Licenses:	CRI (A) MEP	Student pilot
Issued by:	DGAC	INAC
Valid ratings:	31/12/2011	21/08/2010
Flight experience:		
Total flight hours:	1998:10	148:10
On type:	86:00	03:00
Latest 90 days:	13:15	50:36
Latest 30 days:	13:15	07:55
Latest 7days:	06:20	03:00
Latest 24 hours:	- - -	- - -
Night flight:	93:05	05:05
Aeronautical Medical Examiner:		
Class:	1& 2	1 & 2
Date:	04/05/2009	17/08/2009
Valid:	08/05/2010	22/08/2010
Limitations:	NIL	NIL

Table 2

Flying Instructor

The flying instructor, age 25, had Spanish nationality. At the time of accident, he had accumulated 1998:00 total flight hours.

His flight experience, in multi-engine aircraft, was 86:00 hours, being obtained in the same type of aircraft (PA 34 Seneca V). From this amount, the flying instructor flew 13:15 hours in the OO-TML aircraft and in VFR conditions. The remaining time was obtained flying CS-DEQ and CS-DER aircrafts.

He last flew at night, with duration of 02:10 hours[4], on May 07th, 2009.

He has last undergone an aviation medical examination in Spain, on May 04th, 2009. He left on vacation on May 25th, alleging fatigue. Meanwhile, he underwent nose surgery, but was not medi-

[4] Seneca V aircraft, CS-DEQ, from Malaga (LEMG) (ATD 18:50) to Ciudade Real (LERL) (ATA 21:00). On this day, the sunset in Malaga was 19:10 UTC

cally examined for the purposes for getting medical certification[5]. He returned from vacation in late August and resumed his air activity on 01st September.

Student pilot

The student pilot, age 18, had Dutch nationality. He had accumulated 148:00 hours of flying experience, 03:00 of which was in the Seneca V aircraft.

1.6 Aircraft information

The aircraft, Piper PA-34-220T Seneca V, S/N 3449089, was manufactured by Piper in 1998 and registered as N4137X. Meanwhile, it was acquired by Air Flight Academy N.V. (BAFA) based in Deurne - Belgium, the current owner. On January 06th, 2006, it was registered as OO-TML (Belgian Registration Certificate, No. 5064 BCAA).

Reference	Cell	Motor #1	Motor #2	Propeller #1	Propeller #2
Type:	PIPER	Continental	Continental	MC Cauley	MC Cauley
Model:	PA-34-220T	TSIO360RB	LTSIO360RB	3AF32C522	3AF32C523
	Seneca V			/82NJA-6	/L82NJA-6
Serial number:	34-49089	819282	819532		
Year of production:	1998	2007	2007		
Flying time:	5966:10	1375:28	1375:28		

Table 3.

1.6.1 Airworthiness and maintenance

On March 28th, 2007, the BCAA issued a Form Feature including FAA TC Type Certificate Nº A7SO, installation approval for the kit Nº 766-632 and the Certificate of Airworthiness (Normal Category Aircraft, CS-23).

On April 4th, 2009 a Noise Certificate Nº 377 was issued with the following note: "Installed Piper Kit Nº 766-632 (MTOM reduced to 1999. Kg = 4407 pounds)."

On April 7th, 2009, BCAA issued Airworthiness Revised Certificate (ARC) in accordance with Regulation (EC) Nº 216/2008, valid until April 06th, 2010.

On March 19th, 2009, BCAA issued an Aircraft Type Rating for General Aviation and Training Operations (under VFR, IFR, day or night conditions), valid until March 19th, 2010.

On June 17th, 2009 the aircraft flew from Deurne, Belgium, to Évora, Portugal, where it landed on the day after, with a total 5.563:00 hours of flying time. From this date on, it was at the AAE service under leasing agreement.

[5] JAR-FCL 3.040 – ***Decrease in medical fitness -*** *…(c) Holders of medical certificates shall, without undue delay, seek the advice of the AMS, an AMC or an AME when becoming aware of: (1) hospital or clinic admission for more than 12 hours; or (2) surgical operation or invasive procedure……*

The last 100 hours inspection was performed on September 10th, 2009, by AAE Maintenance unit, Part-145 AMO PT-145.009, in accordance with Maintenance Manual ref. 761-888 (last revision of the document approved on February 28th, 2009).

The manufacturer required a "Special[6] flaps Inspection" every 200 flight hours for aircraft which have accumulated over 10 years of service time (in *Special Inspections Maintenance Manual PA-34-220T Seneca IV/V, 5-30-00*). The IT did not find any record/log of such flaps special inspections.

1.6.2 Mass and Balance

The last aircraft weighing[7] took place on March 24th, 2005. The latest changes in weight and balance documents were introduced on March 05th, 2007 and then recorded the following values expressed in the table 4:

Empty Weight	Arm	Moment	MTOM	Useful load
3620.80 pounds	87.8783 inches	318189.6060 lb-inches	4407.00 pounds	786.2 pounds

Table 4

In Seville, the aircraft was refuelled with 61,552 USG of AVGAS being filled with a total of 100 USG, according to the *Log Book*. The flight plan indicated 04:30 hour's endurance which matches with the fuel on board. The fuel tanks had a capacity of 128 USG (equivalent to 768 pounds of AVGAS 100LL at a density of 0.718). 3,8 USG of fuel was considered for engines heating and taxing.

Mass and centre of gravity calculations indicate that the aircraft would be about 4.768,8 lbs take-off mass from Seville (MTOM = 4407 lbs) and at the accident time, would have a mass of about 4.558,8 lbs. At that time, the centre of gravity would be within the flight envelope limits, near to the forward limit (check "*landing mass*" in table 6).

[6] Wing flaps interior inspection (Repeat interval 200 FH). 13 out 2008 5202:40 - no findings. 12 Feb 2009 5397:00 – no findings.

[7] According to Belgian legislation the aircraft has been weighed every 10 years.

LOADSHEET		Mass	Mass	Arm	Moment
		Kgs/USG	(lbs)	(in)	In. Lbs /1000
Basic Empty Mass +			3620,8	87,88	318189,75
Front Seats:	Pilot	80	175,0	85,50	14962,50
	Pax	90	198,0	85,50	16929,00
Centre Seats:	Pax 1	90	198,0	119,10	23581,80
Rear Seats:	Pax 1		0	157,60	0
ZERO FUEL MASS =			4191,8	89,14	373663,05
Total Fuel:___ USG (MAX. 122 USG) +		100	600,0	93,60	56160,00
RAMP MASS (MAX. 4431 lbs) =			**4791,8**	89,70	429823,05
Taxi Fuel: ____USG as applicable –		3,8	23	93,60	2152,80
TAKE-OFF MASS (MAX. 4407 lbs) =			**4768,8**	89,68	427670,25
Trip Fuel: ____ USG –		35	210	93,60	19656,00
MASS AT THE TIME OF ACCIDENT (Lbs) =			**4558,8**	89,50	408014,25

Table 5

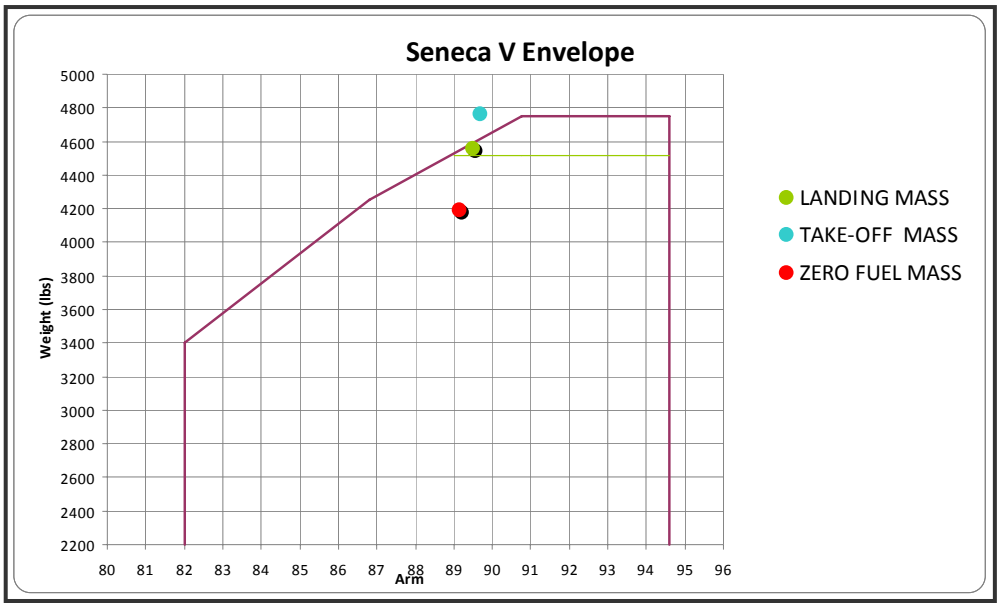


Table 6

1.7 Meteorological information

Pilots flying in the vicinity, at the same time, reported that there was a thin Stratus cloud layer between 9.000ft and 10.000ft.

Inhabitants of the villages near the crash site claimed that the visibility was good.

The enroute information on atmospheric conditions was available for the crew.

According to information provided by IM on September 15th, 2009, based upon: synoptic analysis of weather charts, weather radar images, data from the Detection and Location of Lightning system and observations provided by local meteorological stations, the weather situation in the southern region of Portugal was: the skies were generally clear, the wind blowing weak to moderate from northwest (wind speed 8 to 10 kt) and there was no precipitation.

On the flight route Faro – Évora, between Faro and Sete area and up to 10.000ft, by 21:55 (local time) it was night, the sky was clear (0/8) in the southern part of the route and clear or FEW (0/8 to 1/8) in the northern part of the route, with Alto Cumulus with base at about 2.600 meters (8.500ft) altitude. At 5.000ft the wind blowing weakly from north sector (wind speed about 8 kt), the air temperature would be about 12°C and 50% relative humidity was present at the northern part of the route. At 10.000ft wind blowing moderate from the northwest (wind speed about 10 kt), the air temperature would be about 03ºC and relative humidity 20%.

The QNH in Faro was 1009.9 hPa and in Beja Air Base was 1011.3 hPa.

1.8 Aids to navigation

There were several aids to navigation available along the flight route, namely Faro VORDME, Beja VORTAC. There were also various Radar stations available of the type MSSR.

1.9 Communications

The crew kept two-way communications with Faro Approach on the frequency 119.4 MHz.

All communications between crew and ATC were collected and analyzed by the IT.

With the read-out of ATC records it was found that the communications were standard and perfectly audible. The last crew communication with ATC was registered at 20:44:28, when the crew was allowed to climb up to FL 080.

At 20:53:24 Faro Approach call Diana 11 requesting it to contact Lisbon Approach on frequency 125.55 MHz. Diana 11 crew did not reply to this call or to any further calls.

There are no records or any detection of emergency communication declared by the aircraft crew.

A distress MAYDAY call, emitted from an unidentified source and context, has been heard at the same time, by the AAE operations frequency.

1.10 Aerodrome information

Not applicable

1.11 Flight recorders

The aircraft was not equipped neither FDR nor CVR. Neither one was required by the applicable regulations.

The aircraft was equipped with a digital recorder (Digital Voice Recorder (DVRi-XT), installed on the left side of the instrument panel, with the ability to record communications captured from outside[8]. The recorder is designed to engage a battery that allows it to save the last five minutes of recording, during a time ranging from 1-2 months.

Figure 2.

The DVRi–XT was installed on the instrument panel and remained intact. This equipment was delivered to a certified service for data extraction. Nevertheless, the company's experts did not identify any record of communications, just noise.

1.12 Wreckage and impact information

The accident occurred in a flat area, roughly one NM north of a village with nearly 400 inhabitants. The wreckage was found scattered over an area of 50 hectares of agricultural land not cultivated.

The wreckage track was oriented towards 320º (40º to the left of Route 360º).

The first aircraft component (left flap) was on the right side of the wreckage line.

About 40 meters further on, also on the right hand side, were some of the aircraft documents and one clipboard with the name of the student pilot flying on the back seat.

Figure 3.

Figure 4.

[8] Depending on the type of installation, this type of equipment has the capability to record cockpit communications (intercom). However, this DVR, as installed in the OO-TML aircraft, not allowed recording the intercom communications.

On same line of the flight as the clipboard, perpendicular to the wreckage line, several pieces of glass and plastic from canopy and from windows were found, as well.

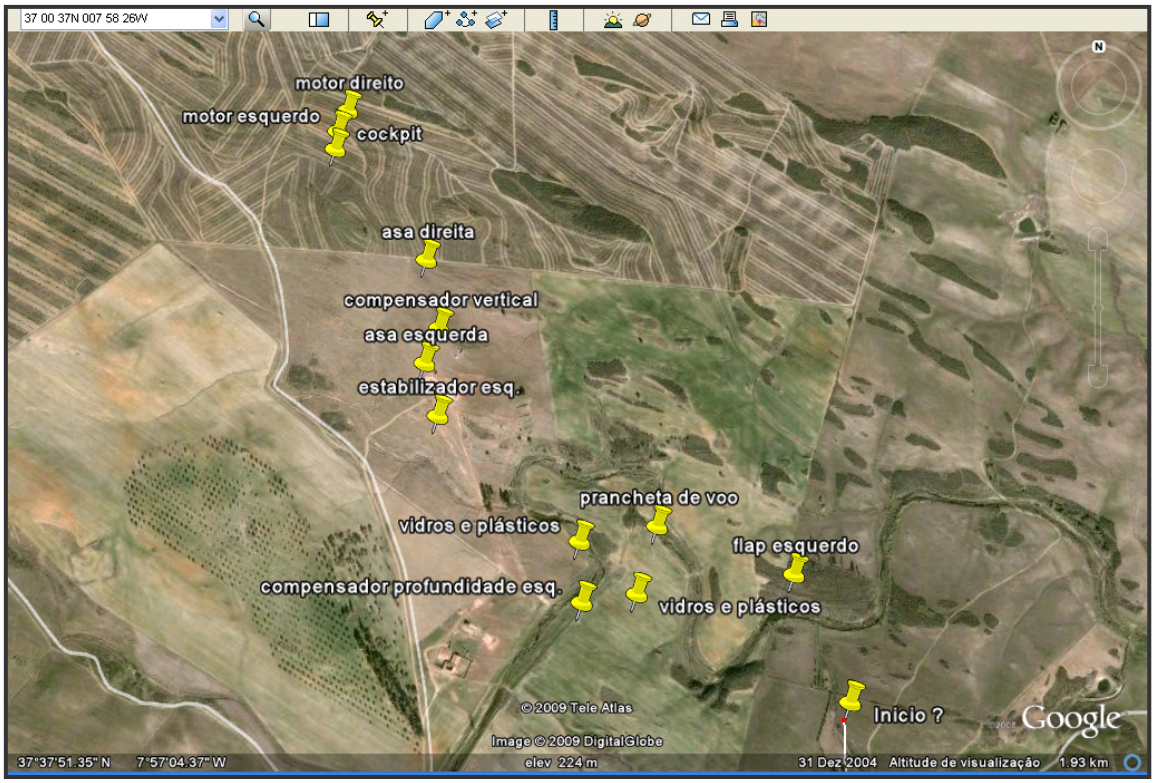


Figure 5

A little further on the left hand side was stabilator left trim.

The remaining aircraft pieces were located in relative positions of their respective sides of debris track (meaning the right wing in the right hand side, left wing in the left side. etc.).

The left engine was separated from the structure.

One main landing gear was extended in its half-way position.

The left engine propeller (rotating clockwise) had two blade tips slightly bent and the other blade was bent (90°) at 1/3 from its root.

The right engine propeller (which rotates counter clockwise) had their three blade tips bent.

The vertical stabilizer was detached presenting marks of having been pulled out from left to right relatively to the direction of aircraft path.

All fracture surfaces examined present consistent indices of overload failure. The wreckage distribution at the scene was consistent with structural failure of the aircraft inflight.

human body location	1
human body location	2
Parker hydraulic pump	3
left engine	4
cockpit instrument panel & nose gear	5
back seat fuselage section	6
right engine 347 deg track	7
seat	8
tail/empennage section	9
centre console with fuel transfer & cab heat	10
small part 2.5" p/n 9628/-3E5299	11
left wing section	12
ident switch from control wheel horn	13
right wing section	14
wing tip light	15
vertical stab	16
nose cone	17
stabiliser (left)	18
unknown visible in GPIAA photo	19
fuselage section with ML letters	20
fuel system sum drain plastic cover	21
interior parts	22
aluminium knee board	23
carpet 30"x10" p/n 85210-27	24
cockpit roof piece	25
interior part A/C 449089 10"x7"	26
knee board & structure	27
glass & plastic	28
stabiliser tab	29
glass & plastic	30
flight manual	31
interior part 90 deg bend	32
engine cowling	33
carpet 31"x3"	34
med kit 8"x11"	35
fibre carbon	36
20"x8" alum sheet	37
left flap	38

Wreckage Distribution Diagram

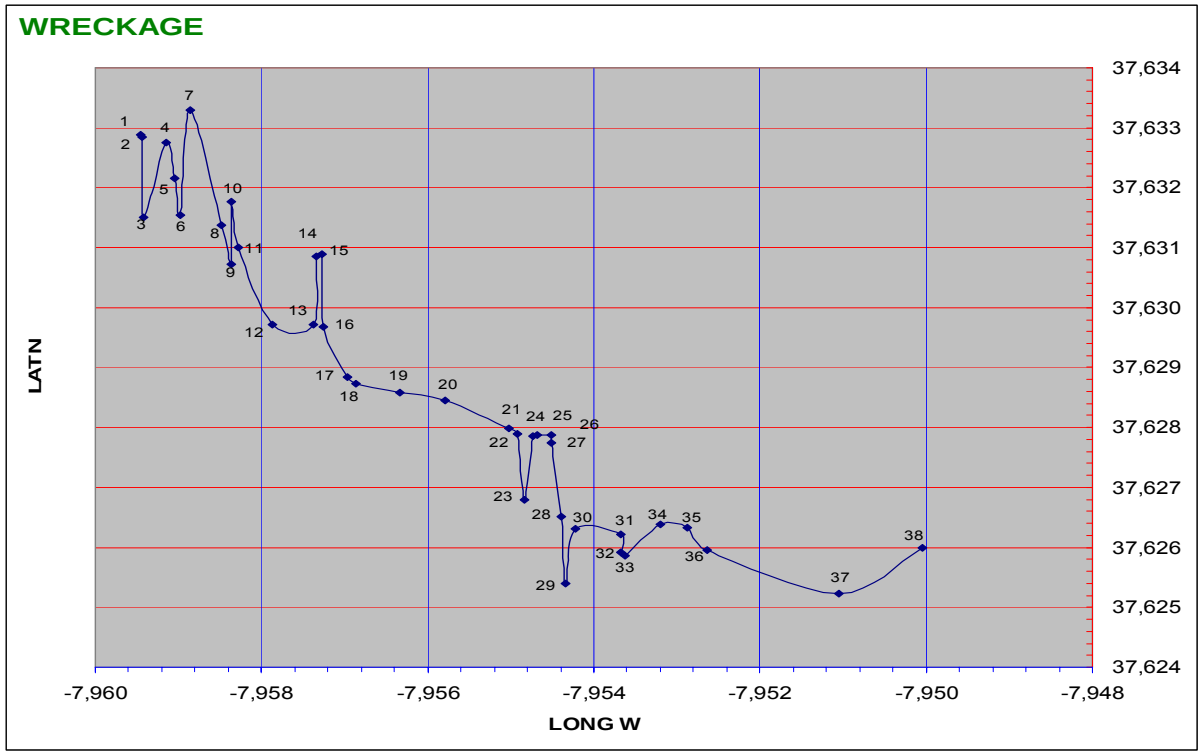


Table 7.

Flight control and instruments

The flight instrument panel was upside down.

The engine #2 fuel selector was in *crossfeed* position. Their straps were attached to other components of the aircraft and they dragged the selector for that position.

The elevator trim indicator showed a slight back compensation.

The rudder trim indicator showed a slight left compensation.

The throttle control, mixture control and RPM levers were in "*all maximum ahead*" position. The flap selector and the gear levers were in the neutral position. The flight director was selected in "NAV APP".

On the left panel, the heading 005° was selected in HSI, the artificial horizon indicated 30° banking inverted to the left, the thermometer 11ºC, the *gyro vacuum* 36 inches, the vertical speed indicator 1.400 ft/min descent rate, the altimeter showed 980ft and the altimeter setting was 29.80" Hg in the Kollsman window.

On the right panel the HSI was on 295º, the air speed indicator 138 kt, the artificial horizon 30º of bank inverted to the left, the altimeter 900ft (29.92" Hg). The vertical speed indicator pointer was indicating DOWN > 2000ft and placed in its extreme position.

The ELT equipment was labelled with "inop" sign.

1.13 Medical and pathological information

There is no medical evidence that physiological factors or physical disabilities had affected the performance of crew members.

An insulin pen was found in the wreckage scene, which a validity that had expired in 2008. Nevertheless, the IT sent the pen to the suitable laboratory, representative of the brand, which has produced a detailed report where it declines the possibility of had been used recently and, particularly, by any occupant of the aircraft.

1.14 Fire

There was no evidence of fire, inflight or after impact.

1.15 Survival aspects

The aircraft breakup inflight and its impact roughness have conditioned the occupant's survival. The alarm warning was given by the local inhabitants after realizing the crash of the aircraft and immediately they phoned to ANPC.

The two pilots had their seat belts fasten. The other crew member was thrown out and he was found about 40 meters before them.

1.16 Tests and research

The aircraft's two engines were sent to the manufacturer "Teledyne Continental Motors, Inc." in the U.S. where they were examined in the presence of an NTSB investigator. The transcript of the expert's report is summarised as follows: ***inspection of the engine did not reveal any pre-impact abnormalities that would have prevented normal operation and production of rated horsepower***. (check full reports in the annex F)

The expert evaluation of the instruments was made by Alverca Company, which is certified in aviation instruments research. Special attention was required to verify the operation of the switches on the left control yoke. The testing to the *A/P disconnected switch* were not conclusive regarding to its effective operation.

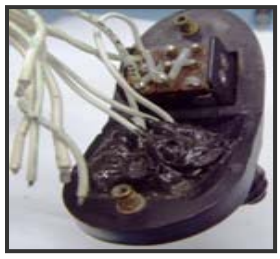


Figure 6.

GPS Bendix/King KLN 90B model P/N 066-04031-1122 S/N 26469 was recovered from the accident and it was damaged. The outer box was warped which caused damage to the internal memory. The IT has initially contacted the "Honeywell Aerospace" and, at a later stage, the BEA (France) to obtain information from this unit. However, the information stored in volatile memory is lost when the electricity power cut occurred.

The elevator trim actuator was found at the maximum *pitch down* position.

The remaining wreckage of the aircraft was sent to the Department of Aerospace Sciences at the University of Beira Interior (UBI), located in Covilhã, where it was submitted to various types of structural tests:

Figure 7.

"…Microscopic analysis to the fracture surface of the left wing longeron, which showed strong deformation in the area of attachment to the fuselage, and that it has been bent according to the plan of wing flexion, revealed that the stringer was not broken resulting of any structural fatigue. IT found clear evidence of plastic deformation of the component that resulted in ductile rupture, which means that the wing has broken due to an overload factor (e.g., exceeded the structural strength of the material).

The left flap attachment was analyzed paying particular attention to the detection of any galvanic corrosion traces which might affect the flap attachments, taking into account the manufacturer's recommendations in this regard. The experts found no traces of corrosion in the *flaps* components.

The deformation of *flap* skin and cracked surface rivets, used in the attachments, indicated that this component was "snatched" from the wing due to some kind of overload ..." (see Annex E).

1.17 Organizational and management information

The operator was a private Pilot Academy certified by Civil Aviation National Authority and based at Évora aerodrome.

In 2009 the Academy was experiencing a boom in student pilots. Such an increase in activity was not duly followed by an upgrading of its structure or by a growth in human resources, particularly in maintenance area.

During 2009, the period between April 13th and September 15th, the academy's aircraft were involved in nine incidents during the landing phase[9].

Moreover, the flight instruction syllabus did not consider the recovery of aircraft from unusual attitudes, neither by visual references nor by instruments.

The Civil Aviation National Authority also did not require such training as mandatory.

1.18 Additional information

1.18.1 Differences between aircraft SENECA Operator

The aircraft with registration marks OO-TML (s/n 3449089) arrived at Évora, on July 18th, 2009, and was included into the AAE fleet where already existed two Seneca V aircraft, with registration marks CS-DEQ (s/n 3449233) and CS-DER (s/n 3449236), respectively. The aircraft registration OO-TML possessed some differences from the other two Seneca V aircrafts operated by the AAE (see table 8.)

The aircraft registration OO-TML had higher basic empty mass and was certified to lower MTOM. On the other hand, the KFC 150 autopilot installed in the OO-TML differed from STC 55x autopilot installed on other aircrafts. There were also some differences in the instrument panel, especially on the right hand side.

Registration marks	Basic Empty Mass (Lbs)	MTOM (Lbs)	Payload (Lbs)	C.G. Arm (Inches)	Moment (Lbs - in)	Auto Pilot
OO–TML	3 620,8	4 407,0[10]	786,2	87,87	318-160	KFC 150
CS–DEQ CS–DER	3 555,5	4 750,0	1 194,5	88,04	313-026	STC 55X
Difference	65,3	**343,0**	**408,3**	0,17	5-134	

Table 8.

1.18.2 Other occurrences involving stabilator trim on same aircraft

[9] Three of these incidents were due to landings with the gear up.
[10] MTOM certified after KIT nº 766 – 632 setting up.

In previous flights there had been some occurrences related to the malfunctioning of the electric stabilator trim. Some of these events had neither been written down in the aircraft *Log Book* nor reported to the maintenance unit.

The following statements were made under circumstance of anonymity, by flying instructors and students who have experienced problems with such trim operation.

List of malfunctions of electrical trim

Report by pilot A

Trim locked during run up Reported to Maintenance.

Report by pilot B

One month ago, it happened to me a strange malfunction of the electrical trim during a navigation flight. We were established at a cruise altitude (probably FL090) and we were requested from Faro Approach to start descending to an altitude (probably 4000 or 3000 ft) in order to perform an ILS approach. We were not using Autopilot or Flight Director. During the levelling-off procedure, the student told me that the electrical trim was not working any more, so I requested him/her to use the pitch trim manually. He/she tried, but the pitch trim was stucked and was not possible to move the pitch trim towards UP position. Immediately I pulled-out the "Pitch trim" circuit breaker and the trim was released (unblocked); we continued the rest of the descent and the approach trimming manually. This problem didn't cause any loss of altitude as soon as my reaction was to pull-out the circuit breaker immediately.

After performing the ILS approach at Faro and when established again at any cruise altitude (probably FL080 or FL100), I decided to check again the malfunction of the electrical trim. I reset the circuit breaker and the electrical trim was working perfectly. The problem was not duplicated any more and we continued the flight using not only the electrical trim but the Autopilot as well finding no more problems during the rest of the flight. Not reported to maintenance

Report by pilot C

Monday 14th September;

During a level flight the student noticed a electrical trim runaway, the autopilot was NOT being used the student advised me about it and I told him to push and hold the autopilot disconnect button (red button on left control yoke) so stopping the trim runaway while I looked for the breaker and pulled it. No further problem was encountered during the flight.

While taxiing back to the parking I reset the breaker and checked again the trim, no malfunction was noticed. The problem was not reported to maintenance as I forgot it

due to the few time I had before starting my next activity (simulator session) so I just could jump out of the plane and rush for it.

Tuesday 15th September;
The mission conducted was use of autopilot and flight director, so both were used along the flight normally using them until few minutes before the approach when became disengaged as the student wasn't completely able to manage the approach and the flight director at the same time. During the whole flight no problem was experienced about the auto flight system. Nothing was reported as it worked perfectly.

Report by pilot D

Trim runs away during AP test on the ground a couple of times: not reported.

Report by pilot E

Detected from the 8 to the 15th of September:
Electrical trim blocked during two occasions, and back to move by using the electrical trim selector.

Report by pilot F.

On the 14th of September 2009, one day before the accident with the Seneca V, OO - TML, I had a flight with that plane, with an instructor.
In the before taxi checklist we have to check the electrical trim, witch I did, and it was working. After that, in the holding position, we have to do the before take-off checklist and among other items check if both trims are neutral. I noticed that the pitch trim was in the most nose down position. I was almost sure that when I checked if the electrical trim was working I lefted in the neutral position but it wasn't. I used the manual pitch trim to put it again on neutral.
It was a visual flight to train air work and circuits in N-1, so we did an N departure and went to Arraiolos. I was always using the electrical trim. When we were leaving Arraiolos inbound Vimieiro, and already at 3000 ft, suddenly the plane was pitching down. I tried to pull the controls backward but I couldn't, it was stuck in the nose down position. Quickly the instructor said it was a trim runaway and solved it, I'm not sure how, but he explained to me that it was solved by pulling the circuit breaker and pressing the control wheel steering. He told me to start using only the manual trim for the rest of the flight.

1.18.3 Autopilot and trim troubleshooting

According to the pilots operating hand book in the event of an autopilot malfunction, or if at any time it is not working properly or not following the instructions as expected, do not try to identify the cause of the system problem.

The pilot shall immediately recover the flight control, overlapping the AP action as needed, disconnect immediately the autopilot and do not reengage it before the problem has been identified and solved.

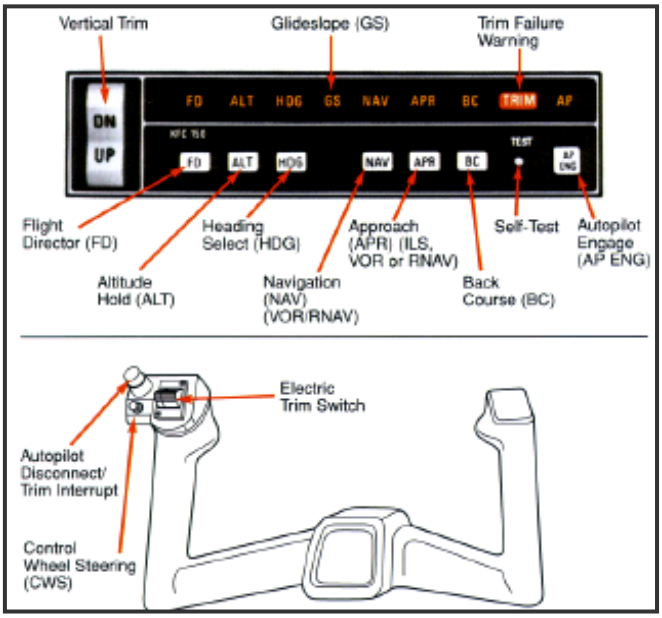


Figure 8.

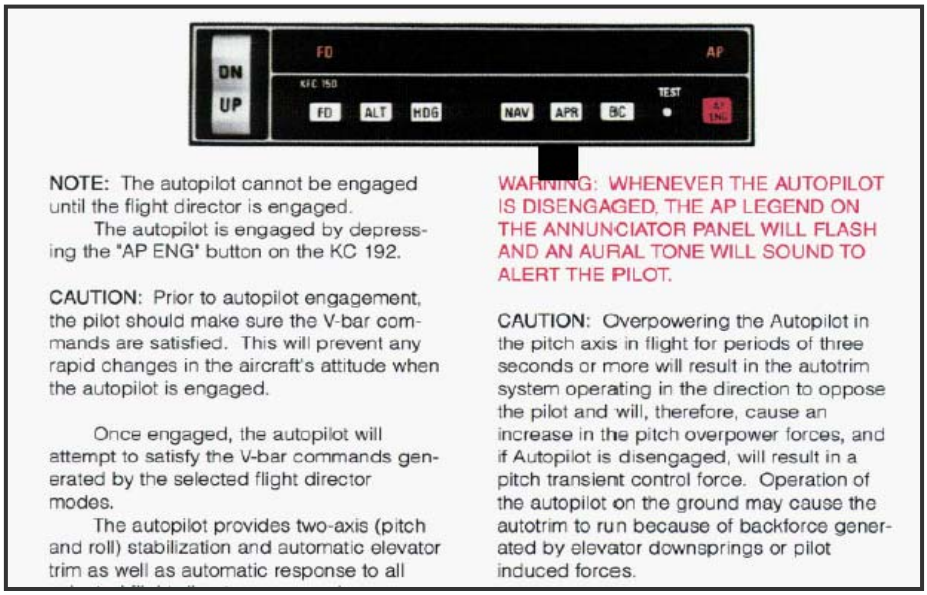


Figure 9.

The Autopilot can be disconnected as follows: (1) pressing the "AP Disconnect Switch" located on the left side of the left yoke, (2) selecting "OFF" position on the "AP Master Switch", (3) brief power cutting through the "Battery Master Switch", (4) pulling the autopilot circuit breaker.

In the event of a trim failure the pilot shall control the aircraft manually and press the "AP Disconnect Switch/Trim interrupt"; set the "Trim Master Switch" in "OFF" position, pulling its circuit

breaker and leave the "Interrupt Switch"; compensate the aircraft keeping the trim system OFF until the problem is solved.

An autopilot malfunction during climb, cruise or descent, if the suiting recovery procedure occurs with three seconds delay, it might generate a bank of about 57° and 380ft of altitude lost.

An autopilot or automatic trim malfunction, during an approach, with one second of recovery starting delay, it might result in 20° bank and 60ft of altitude lost.

The instruction regarding to the autopilot KFC 150 operation was not included in Chapter 9 (*Supplements*) of the *Pilot's Operating Handbook* (POH), 1996 version revised in 2001. This manual has been provided to ATPL (A)[11] pilot students.

2. Analysis

2.1 General

The instructor and student pilot were duly certified and qualified in accordance with national regulations.

The aircraft was properly certificated.

The Flight Manual did not include autopilot procedures.

The wreckage distribution over a very large area showed a structural failure of the aircraft in-flight.

The pieces collected showed no evidence of engine or even systems failures.

The accident was unlikely to have any survivors

The aircraft maintenance service did not accomplish with a special inspection to the *flaps* core for detection of galvanic corrosion. Nevertheless, the examination to the flaps debris did not identify any point of corrosion which might contribute to the accident.

The expert assessment performed to the engines did not detect the presence of any anomalies that would prevent their normal operation and power generation before impacting.

The expert assessment of the aircraft structure has not detected any evidence of structural failure modes of the material itself, namely, fatigue and corrosion.

The IT has covered and discussed the following information

- Crew qualifications and their flying experience;
- Publications;
- Weight and balance computations;
- Occupant's seat belts utilization;

[11] The pilots would have to know how to disengage the autopilot and how to disconnect the elevator electric trim through *disconnected button* by memory and reference to the checklist.

- Aircraft maintenance;
- Autopilot system;
- Human factors;
- ATC Radar information.

Finally, the IT pondered and generated a credible hypothesis.

2.2 Flight operations

2.2.1 Crew qualification and flight experience

Flying Instructor

The flying instructor was properly licensed and qualified to operate the aircraft. His experience, accumulated in this type of aircraft, was 86:00 hours of flight. From these, he has flown 13:15 hours, previously, on the crashed aircraft and the remaining time in aircraft Seneca V equipped with autopilots distinct from that installed in the crashed aircraft. The PI flight activity, during the latest 90 days preceding the accident, summed up to 13:15 hours in VFR conditions.

The last night flight of the PI was dated May 07th, 2009. The flight lasted 02:10 and the aircraft took off from LEMG at 20 minutes before sunset. The pilot registered 02:10 night flight in his pilot log book[12], as though the flight had been made totally under special conditions of night flight time[13].

Analogous situations were evidenced in the "special conditions of flight" record, where total flight time was deemed to have taken place in IFR conditions while in reality the operation has taken place from the aerodrome of Évora[14], where only VFR air traffic is allowed and there is no instruments landing approach procedure.

These facts confirm the existence of significant differences between the flight hours recorded as "night flight" and "instrument flying" and the real time flown by the pilot in such special conditions of flight.

Student Pilot

The student pilot was licensed to operate the aircraft and was flying his third flight mission and the first night flight in a twin-engine aircraft. In the flying course program, the navigation flight was only foreseen for a later stage, when the student has already accumulated some flying experience in the airplane. The IT believes that a student with little flight experience on this aircraft type may not be able to deal with or adequately resolve situations that require his immediate intervention, aggravated particularly in conditions of night flight.

[12] The pilot logbook is the official registration document specifying that night flight is comprised between evening (dusk) civil twilight and the beginning of morning (dawn) civil twilight.
[13] It was assumed the flight has lasted 01:20 hours
[14] At Évora, the daily Sun light average is longer than 12 hours

On the other hand, the student pilot had available a *Pilot's Operating Handbook* (POH), 1996 version and revised in 2001, which did not include in Chapter 9 (*Supplements*) procedures relating to the autopilot KFC 150 equipment.

2.2.2 Operational procedures

Weight and balance computations

The aircraft was certified for MTOM 4.407,0 Lbs. The weight and balance calculations show that the aircraft took off from Seville 4.768,8 lbs, roughly 360 lbs above the MTOM, and at XAPAS it would have already flown within the flight envelope although in a forward position (see table 6).

This finding caused surprise among some AAE technical staff, sceptical about the possibility of an aircraft with capacity for six occupants might overcome the MTOM carrying on board only three occupants plus 600 lbs of fuel.

On the other hand, the OO-TML Navigation Logbook recorded 01:45 hours flying time, performed on the same day of the accident, in which the aircraft carried six people on board. Nevertheless, if the weight and balance calculations are based on 768,2 lbs payload = (fuel + occupants mass) plus the fuel needs for 01:45 hour flight, as a result, the aircraft could not carry more than three adults, for not exceeding the certified MTOM.

These facts illustrate improper operating practices, which may be related to the routine exploitation of the other Seneca aircrafts belonging to this Operator, certified for a MTOM of 4.750 Lbs.

Occupant's seat belts use

The aircraft did an approach followed by "touch-and-go" on Faro International Airport runway.

This makeover was video taped by the student pilot who was travelling as a crew member behind the pilots, and in order to achieve that film he had to move forward and positioning closer, at the back and middle, of the other two crew members. Knowing that the airplane has no seat in that position, it should be concluded that this occupant was not wearing seat belts during this critical phase of the flight.

This finding indicates that the "*seatbelts fasten*" item was not fulfilled, which is one of mandatory procedure of the "*approach checklist*", which constitutes a conflicting procedure to the principles of flight safety and contrary to recommended practice for a flight instruction school, as well.

Publications

The *Pilots Operating Handbook* (POH), which has been distributed to student pilots, was a 1996 version, revised in 2001, in which chapter 9 (Supplements) did not include the procedures for the autopilot KFC 150 operation.

The lack of knowledge, concerning the "autopilot KFC 150" performance, is evident in some reports included in the "List of malfunctions of electrical trim" (see paragraph 1.18.2) particularly with regard to run away trim events, occurred with the aircraft on the ground. This occurrence is foreseen in the manual of the equipment under the title of "*emergency procedures*": "*operating*

the autopilot on the ground may cause the auto trim to run, because of back forces generate by elevator down springs or pilot induced forces" (see Figure 9).

2.3 Aircraft

Aircraft maintenance

The *Maintenance Manual PA-34-220T Seneca IV/V (5-30-00)* requires a special inspection, every 200 fh, to aircraft *flaps* interior which had accumulated longer than 10 years of service. The last inspection of the flaps was carried out in Belgium on February 12th, 2009 (5397:00 fh). From this date onwards there are no records to any *flaps* inside inspections, which mean that there was a deficit of two *flaps* inspections.
The knowledge of such a situation has prompted a request to the engineers of the UBI Department of Aerospace Science to devote special attention to the *flaps* technical analysis. The experts did not detect any corrosion evidence or other non-conformities linked to the *flaps*.

Autopilot

The *autopilot disconnected switch* was installed on the left yoke only. In this case, involving an instructional aircraft where the instructor is seated on the right hand side, it is reckoned by the manufacturer, that the installation of another *autopilot disconnected switch* on the right yoke, should be required, to facilitate pilot intervention if necessary, to resolve a *run away trim* situation.

The remaining two Seneca aircrafts of this Operator - those in which the PI had more flight experience - were equipped with autopilots STC 55x whose characteristics allow the pilot, seated at the right side, to solve a *run away trim* occurrence without having to interfere in the left yoke.

2.4 Human Factors

The PI confided to his girlfriend his concern for the air safety status in view of which he would quit his job and enrol at the University of Seville.

In May, he requested advanced holidays claiming fatigue. He apparently enjoyed vacationing during the three summer months, although in this period he underwent nose surgery, after which he was not checked by and air medical doctor as specified in JAR-FCL 3040.

The IT was unable to find out the reasons why the PI has referred to the safety concerns.

The fatigue, a factor which may decrease the concentration and reaction time of pilots to new situations, was not considered as a contributing factor.

2.5 ATC radar information

MSSR ATC Radar plotting and records, including Beja (*mode ident S capability*), Lisbon, Faro and Fóia (*mode ident A and C capability*) indicate that the aircraft climbed normally up to FL 080 and has remained levelled for the period of 40 seconds before entering in an abrupt descent. The crew did not report at the XAPAS (reporting point – compulsory Fly By) or even responded

to calls from ATC. These facts suggest that the problems with the aircraft may be related to the execution of procedures or any equipment activation during the levelling phase.

All radars lost aircraft tracking at the beginning of its descent. However, the Beja MSSR returned to pick up a signal from the aircraft at 4.000ft. IT believes that the loss of information by the four MSRR may be related to the relative position of the transponder antenna in relation to the radar stations, or due to an electrical failure.

It is likely that the aircraft has entered an unusual attitude, near to inverted flight, "hiding" its transponder's antenna from ground radars[15] stations detection, actually located on aircraft underside. Therefore, the register observed only by Beja radar would be justified by the low altitude of the aircraft and its relative proximity.

Another possibility, that would justify the loss of radar signal, is the presence of a total electrical failure in the aircraft which would interrupt the operation of the transponder. In such case, this would be a brief power failure, since the aircraft was again tracked by Beja[16] radar while crossing 4.000ft on its way down.

2.6 Likely hypothesis: "The crew had faced a *run away trim* situation and lost control of the aircraft which entered in a steep descent and exceeded the limits of structural load eventually breaking up in the air."

The radar records showed the aircraft came suddenly into a steep descent. Additionally, the elevator trim actuator was found in an extreme *pitch down* position (see Figure 7) which indicates a kind of *run away trim* occurrence.

This hypothesis is also supported by the testimony of the other pilot's reported problems with the electric trim, especially the one that had occurred on the day before this accident

suddenly the plane was pitching down. I tried to pull the controls backward but I couldn't, it was stuck in the nose down. Quickly the instructor said it was a trim runaway and solved it

The testimonies variety and its distribution over a short period of time reveals that the cause (s) of the problems was not identified (s) and/or eliminated (s) by maintenance technicians who in some cases have not been aware of their occurrence, as they were not reported.

A *run away trim* type of occurrence could be related to the compensation of the aircraft during the levelling off phase, with or without the autopilot engaged. On the other hand, in case the passenger has moved closer to the pilots (most favourable situation with the aircraft levelled),

[15] The MSSR's operation and their outcomes were deeply discussed between IT and the engineers from NAV Portugal, EPE.

[16] This situation was simulated inflight by stopping the power supply of a Seneca V transponder. Then, the radar immediately recovered the aircraft track signal.

the centre of gravity also would moved forward which would make it harder or even though it would be impossible to recover from a *pitch down* situation.

A *run away trim* occurrence demands an immediate suitable response by the instructor, who should maintain control of the aircraft, identify the occurrence, press and hold the AP *disconnected switch*, located on the left side of the student yoke (Figure 10), and finally identifying the "on" and "off" pitch trim circuit breaker, located on the right panel (Figure 11).

Figure 10.

Figure 11.

The IT strongly believes that the short flight instructor experience, in that type of aircraft, aggravated by the fact that it was acquired during an extended period of time and on an aircraft which presented some major differences, associated with night flight conditions, have definitely influenced the events.

Actually, the PI's flying experience in this aircraft was 13:15 hours accumulated during local flights not requiring the use of the autopilot. So, the IT is persuaded that the first PI contact with the KFC 150 autopilot[17] installed on the aircraft has occurred, probably, on the same day of the accident.

A three-second delay in early recovery from an autopilot or elevator trim malfunction situation could imply in aircraft steep banking of 57º. The suitable required experience of the PI would be crucial to recover the aircraft from an unusual attitude, especially because it was a night flight where the use of recovery through instrument[18] means could be essential. The school did not practice the recovery of unusual attitudes based on visual references or instruments and, often, former pilot students progressed to instructor pilots without bridging this gap.

The *pitch trim* circuit breaker was found in the position "on", which may indicate an occurrence of *run away trim*. Furthermore, the instructor could not locate it and/or turn it off before losing control of the aircraft. In an extreme situation, and as a last resource, the instructor could temporarily

[17] Photos from the cockpit of the aircraft, taken at different phases of flight from Seville to Évora show the Flight Director selected in heading and/or altitude and the autopilot is disengaged.

[18] The presence of an enlightened village, on the right hand side of the IP, and a starry night were factors which could contribute to spatial disorientation during recovery from an abnormal attitude induced by external references.

shut down the electrical power through the *Battery master switch*. This momentary loss of power would justify the loss from the aircraft tracking by MSRR's and the subsequent registration of the Beja radar at 4.000ft.

The PI could also have required the intervention of the student pilot, as he was best positioned to press the *AP disconnected switch*, however, the limited experience of the student pilot flying the aircraft and the difficulties inherent to the night flight did not guarantee the success of his proper involvement. In the cases reported previously, it was shown that the flight instructors with experience on the plane easily solved such situations. However, it also found that their students failed to identify the problem and did not know how to handle it.

3. Conclusions

3.1 Findings

1. The crew was licensed and qualified to operate the aircraft;
2. The aircraft was licensed in accordance with regulations;
3. The Flight Manual did not have included auto pilot procedures
4. The aircraft was not undergone the especial technical inspection to the flaps core, for corrosion detection, required to these aircrafts older than 10 years of air service. The experts did not find any corrosion in the flap components;
5. The aircraft took off from Seville with a mass exceeding the 4407 lbs of MTOM to which was certified. At the time of the accident the centre of gravity would be, in a forward position, within the recommended limits;
6. The wreckage was spread within a large ground area indicating that there was a structural failure during flight;
7. The aircraft debris recovered did not show evidences of power or systems failures;
8. The elevator trim actuator was set in extreme position of *nose pitch down*;
9. No survivors could be expected from such an accident;;
10. In the four months previously to the accident, the Operator suffered nine aircraft incidents, in landing phase;
11. The operator did not supply training for recovery of aircraft unusual attitudes neither by visual references nor by instruments, besides the Civil Aviation National Authority did not require this kind of flight training;
12. The Flying Instructors did not practice recovery from unusual attitudes;
13. The flight hours recorded by the flying instructor, as having been made in special flight conditions (IFR and VN), did not correspond to actual flight hours under those conditions;

14. The PI was unfamiliar of using the KFC 150 autopilot installed on the aircraft;
15. The aircraft has experienced, previously, several problems of elevator trim malfunctioning;
16. The pilots did not report all occurrences in the *Log Book*;
17. The aircraft, with OO-TML registration marks, was certified for a lower MTOM, and equipped with an autopilot different from other two Seneca aircrafts operating in the Academy;
18. The *Pilot's Operating Handbook* delivered to the students did not include, namely in the Chapter 9 (Supplements), operational procedures concerning KFC 150 autopilot. Nevertheless, the pilots should know how to disengage the autopilot and disconnect the elevator electric trim through *disconnected button* from memory and reference to the checklist;
19. There is no evidence that fatigue has been a contributing factor to this accident.

3.2 Probable causes

The IT concluded that the probable cause of this accident was an occurrence classified as *run away trim* type, not adequately addressed by crew, which led to loss of control of aircraft and consequently exceeding the primary structural load limits and a subsequent inflight break-up.

The flying instructor lack of training for recovering unusual attitudes, worsened by the dark conditions and without external references, it was considered as contributing factor.

At the time of the accident the operator did not supply training for recovering unusual attitudes by visual references or instruments, nor was it required by the Civil Aviation National Authority

4. Safety Recommendations

4.1 During the accident investigation the IT recommended to the AAE to implementing an unusual attitudes recovery program aimed to flying instructors.

Actually, the operator agreed with the IT recommendations, taken several other initiatives to prevent recurrences and to enhance the safety of the operation. Accordingly, it has requested the relevant services and aircrafts from a company specialized in acrobatic flight, to establish a training flight schedule to instructor pilots for recovery from unusual attitudes, *vrilles* and spins/spiral dives, beyond the regulations required by.

Meanwhile, the operator required an external auditing to its flight operations, maintenance and flight safety;

The Maintenance Department was then reorganized and the interactions between operations and maintenance were reviewed.

The whole aircraft fleet was inspected by maintenance specialists, external to AAE, and submitted to inflight checks.

It has implemented a new "Safety Management System" including a reporting incidents system, open and non-punitive.

It was introduced new elements of training on the use of the autopilot and elevator trim Seneca aircraft in normal, unusual and emergency situations.

The instruction manuals were reviewed and adjusted in order to take into account the recovery from unusual attitudes.

The Seneca aircraft Manual of Procedures now includes an item related to the autopilot and trim malfunctions;

According to the previous findings and proposals, the IT does not envisage a need to address additional safety recommendations to AAE.

4.2 As a result of the present investigation, IT issues the following further Safety Recommendations to Civil Aviation National Authority:

- INAC shall become closely involved with flight academies to ensure that the ATPL courses include unusual attitudes recovery training by both instruments and visual references. **Safety Recommendation nº 02/2011**
- INAC shall enhance its flight operator's safety oversight to whoever have experimented a swift growth of inflight activity or to whoever have had an aircraft accidents and incidents rate increment. **Safety Recommendation nº 03/2011**

Lisbon, 15th of September, 2011

Safety Investigator	Investigator in Charge	Safety Investigator
		
António Alves	Fernando Lourenço	António Barros

5. ANNEXES

Annex A – Flight Plan

FLIGHT PLAN
PLANO DE VOO

SPECIFIC IDENTIFICATION OF ADDRESSE(S) AND/OR ORIGINATOR
AD: LPBJZPZX LPFRZPZX LEZLZPZX

3 MESSAGE TYPE 7 AIRCRAFT IDENTIFICATION 8 FLIGHT RULES TYPE OF FLIGHT

(FPL - EVR11 - Y X

9 NUMBER TYPE OF AIRCRAFT WAKE TURBULENCE CAT 10 EQUIPMENT

- PA34 / L - SDRG / C

13 DEP AD TIME

- LEZL 1900

15 CRUISING SPEED LEVEL ROUTE

- N0147 F110 → ONUBA R47 MINTA R47 VFA W7 SOTEX/VFR

16 DEST AD TOTAL EET ALTN AD 2ND ALTN AD

- LPEV 0230 → LPFR →

18 OTHER INFORMATION

- REG/OO-TML RMK/CALLSIGN DIANA11 TRAINING FLIGHT
-REQ APP LEZL
-REQ APP LPFR
ANY IFPS CHANGES ARE ACCEPTED
EET MINTA 0040)

SUPPLEMENTARY INFORMATION

19 ENDURANCE PERSON ON BOARD EMERGENCY RADIO
UHF VHF ELBA

- E / 0430 → P / 3 → R /

SURVIVAL EQUIPMENT
POLAR DESERT MARITIME JUNGLE

JACKETS
LIGHT FLUORES UHF VHF

→ S / → J / X

DINGHIES
NUMBER CAPACITY COVER COLOUR

→ D / → → C →

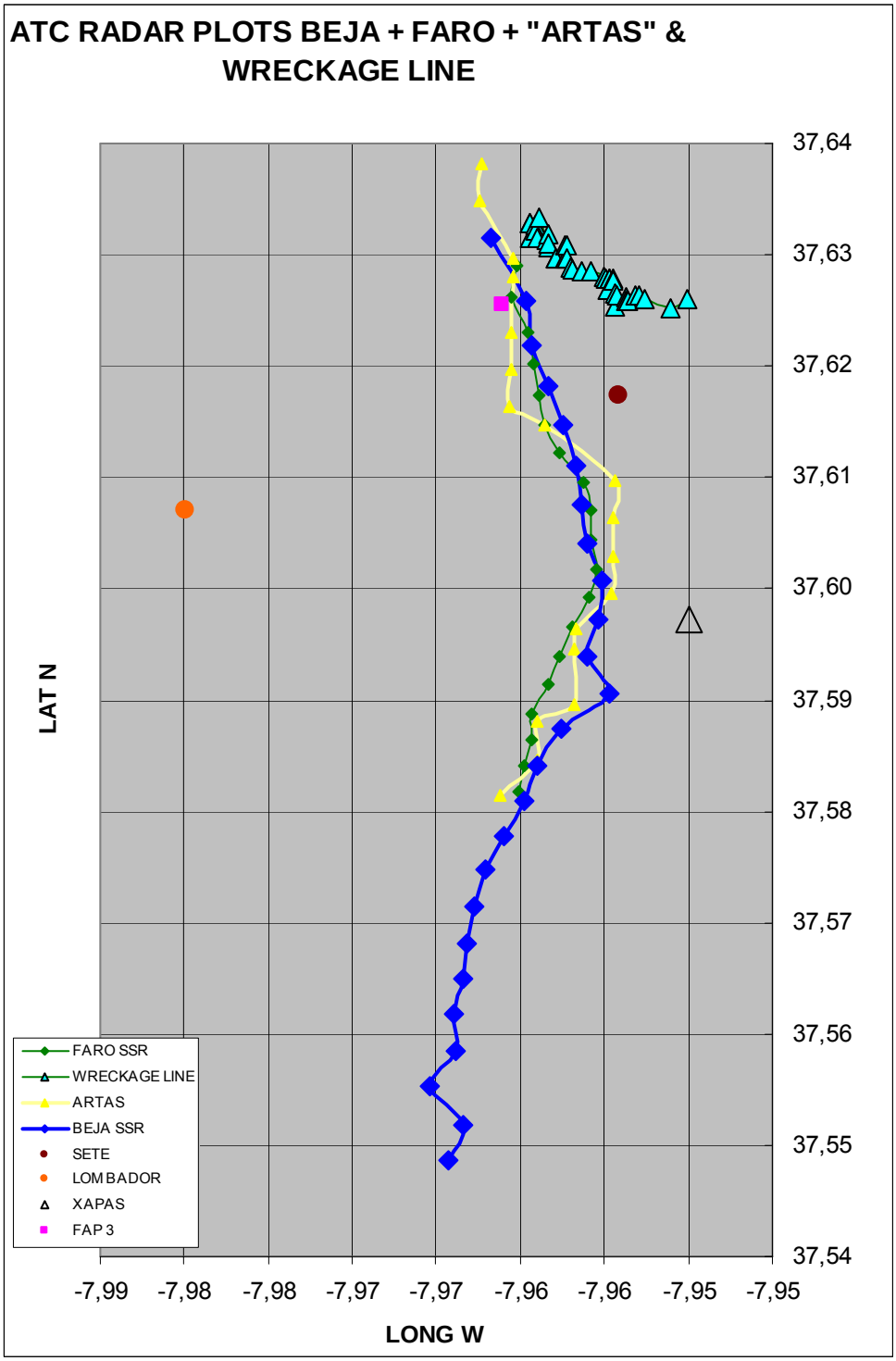
ACFT COLOUR AND MARKINGS
A / WHITE WITH GREEN STRIPES

REMARKS
N /

PILOT - IN - COMMAND
C / J. TERRON)

FILLED BY : D. FALIZE
TEL: FAX:
ADDITIONAL REQUIREMENTS:

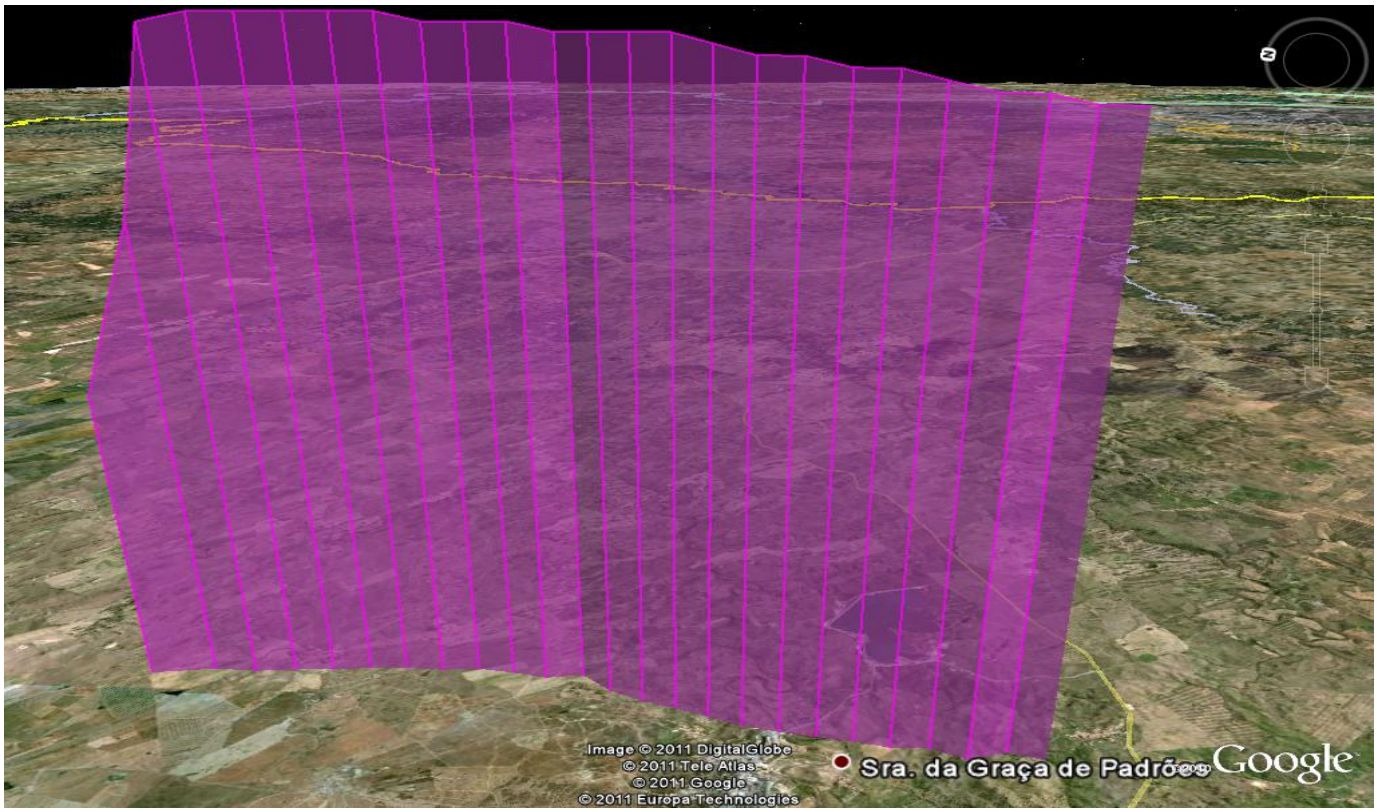
Annex B – MSSR plots



Beja Radar is a MSSR located at 202 meters of altitude (MSL), with a 220 NM operational range. Its antenna has 12 RPM (1 RPM = 5 seconds).

Radar information: Faro, Foia, Lisboa and Montejunto						
Time UTC	Distance NM	Azimuth (T)	Altitude	GS Kt	TH	Radar
20:53.24.02	36.23	001.25	8100	143.70	005.44	Faro
20:53:26.55	35,70	059,45	8100	131,8	001,52	Foia
20:53:28.52	88,67	140,59	8100	138,4	352,00	Lisboa
20:53:31.65	36,56	001,19	8100	144,8	002,99	Faro
20:53:32.33	88,53	140,50	8100	141,9	352,00	Lisboa
20:53:32.56	106,45	150,78	8100	143,0	359,00	Montejunto
20:53:34.18	35,81	058,77	8100	144,6	355,00	Foia
20:53:35.47	36,73	001,16	8000	145,7	001,87	Faro
20:53:36.16	88,39	140,44	8000	144,1	348,00	Lisboa
20:53:39.29	36,91	001,08	7800	146,8	000,57	Faro

Orthogonal projection of the flight track

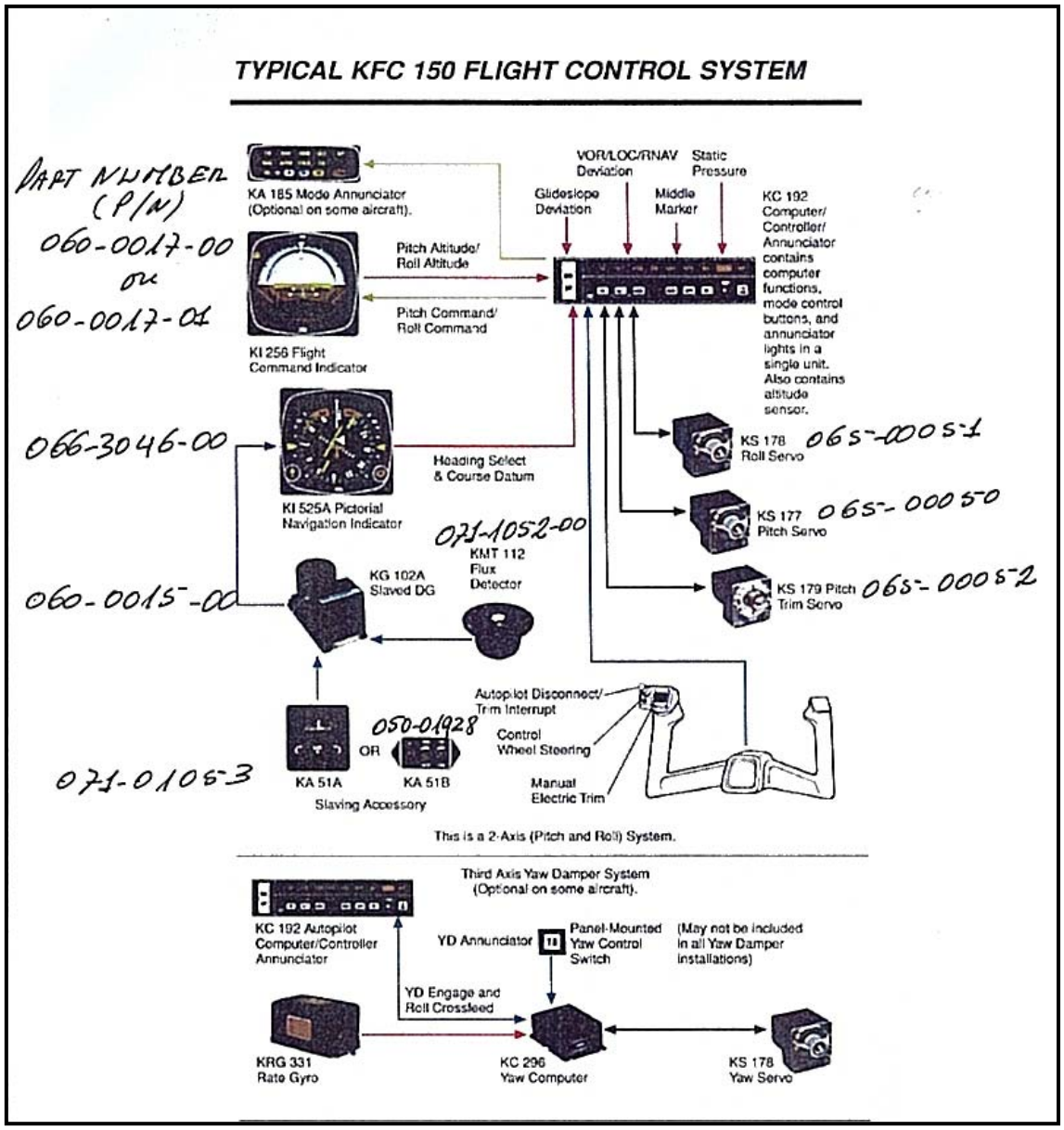


Flight data profile from Beja MSSR

Last 25 plots view from West side of the track

Annex C – Photography's

Annex D – Diagram of typical KFC 150 Flight Control System



Annex E – Report of the expert examination to aircraft primary structure

UNIVERSIDADE DA BEIRA INTERIOR
Faculdade de Engenharia
Departamento de Ciências Aeroespaciais

Relatório da Análise da Estrutura da Aeronave OO-TML

Covilhã
Julho de 2010

1. Objectivo

O presente relatório visa apresentar as conclusões decorrentes da peritagem efectuada à estrutura e alguns componentes seleccionados da aeronave Piper Séneca V, com matrícula OO-TML, a qual sofreu um acidente em 15 de Setembro de 2009, na região de Castro Verde. Os dados apresentados neste relatório seguem uma estruturação de acordo com as orientações e solicitações emanadas pelo GPIAA, designadamente na escolha dos componentes e/ou partes da estrutura da aeronave objecto de uma análise mais pormenorizada. Todos os dados apresentados neste relatório têm um carácter estritamente factual, não tendo sido, em momento algum, adiantada qualquer explicação relativamente aos factores contributivos para o acidente envolvendo esta aeronave.

2. Contextualização sumária do problema

No dia 15 de Setembro de 2009, durante um voo de treino nocturno, o avião bimotor PA34-220T, com matrícula OO-TML e ao serviço da Academia Aeronáutica de Évora (AAE), perdeu contacto radar, pelas 20:53, quando voava a FL080. Pelas 21:45 do mesmo dia, os destroços da aeronave foram encontrados, espalhados por uma grande área, próximo da Aldeia de Sete, Concelho de Castro Verde. A aeronave foi encontrada num estado de destruição extrema, tendo resultado na morte dos seus 3 ocupantes (um instrutor de voo e dois alunos).
Na sequência de um contacto encetado por parte do GPIAA, e no âmbito do protocolo existente entre este Gabinete e a Universidade da Beira Interior (UBI), os destroços da aeronave foram enviados para as instalações desta Universidade no final de Novembro de 2009, tendo em vista a execução de trabalhos de investigação na estrutura e componentes da aeronave, de acordo com orientações fornecidas pelo GPIAA. Na altura, o Investigador Responsável pelo acidente, Sr. Tenente Coronel Fernando Lourenço, teve algumas reuniões com o ponto de contacto do Departamento de Ciências Aeroespaciais (DCA) da UBI, Prof. Doutor José Miguel Silva, de modo a poder facultar um conjunto significativo de informações relativas às circunstâncias do acidente apuradas até à data, e a algumas características técnicas da aeronave essenciais para a investigação. Durante estas reuniões iniciais, foi também manifestado um especial interesse por parte do GPIAA para que os esforços dos trabalhos de investigação na estrutura incidissem, com especial relevância, nalguns componentes específicos, designadamente: flap da asa esquerda (incluindo sistema de accionamento e zonas de fixação à asa), zona de fixação da longarina principal da asa direita com a fuselagem, compensador da empenagem horizontal (incluindo sistema de accionamento) e empenagem vertical.

A equipa do DCA/UBI foi, adicionalmente, informada sobre a possibilidade da aeronave ter sofrido uma falha estrutural catastrófica em voo, hipótese com grande grau de viabilidade atendendo ao diagrama de destroços levantado pela equipa do GPIAA no local do acidente. De facto, este mapa indicava uma clara e extensa linha de destroços orientada a cerca de 40_{o} para a esquerda da rota assumida pela aeronave no último contacto radar, sendo que o primeiro componente identificado (em termos de disposição espacial) seria o flap da asa esquerda. Numa posição significativamente mais à frente, apareceriam os demais componentes, designadamente (e por ordem de disposição espacial), compensadores do leme de profundidade, asas, compensador vertical e motores. Atendendo à extensão considerável da linha de destroços e ao estado de grande deformação da estrutura da aeronave, ganha consistência a hipótese que a aeronave estivesse animada de grande velocidade na altura da provável desintegração em voo e consequente impacto com o solo.

3. Resultados da análise à estrutura

A análise à estrutura e componentes seleccionados da aeronave acidentada baseou-se, essencialmente, num conjunto de observações visuais do estado geral de deformação dos componentes, procurando identificar indícios sobre os modos de falha ocorridos. Em particular, foi dada uma especial relevância à observação do estado superficial dos componentes e a algumas superfícies de fractura, procurando identificar características morfológicas tipicamente associadas a mecanismos de ruína característicos de acidentes com aeronaves, tais como, por exemplo, danos por fadiga, deformação plástica excessiva (i.e., acima da carga limite admissível pela estrutura) e corrosão. Os componentes sujeitos a análise foram fotografados antes e após quaisquer operações de desmontagem necessárias à sua correcta avaliação, de modo a criar um registo sobre a estrutura da aeronave no estado exacto em que a mesma foi recepcionada nas instalações da UBI. Nalgumas situações, e sempre que se justificasse, as observações foram executadas com auxílio de equipamento de microscopia adequado.

Seguidamente, apresentar-se-ão os resultados relativos às diferentes observações corroborados por alguns comentários dos autores deste relatório, os quais seguem uma estruturação consistente com as solicitações específicas recomendadas pelo GPIAA.

3.1 – Análise das asas

As asas da aeronave foram encontradas separadas da fuselagem no local do acidente. Tratando-se de um avião bimotor, com um motor em cada asa, constatou-se que o grupo motopropulsor se encontrava desacoplado de cada uma das superfícies alares, incluindo o berço do motor no caso da asa esquerda. Este facto é indiciador da elevada quantidade de movimento no momento do impacto com o solo, resultando na projecção para a frente dos elementos estruturais com maior massa (como se poderá comprovar pelo diagrama de destroços levantado no local do acidente).

Uma outra constatação imediata diz respeito ao diferente estado de deformação da longarina principal de cada uma das asas junto à raiz, i.e., na secção de fixação à zona central da fuselagem. De facto, a longarina da asa direita apresenta um estado de elevada deformação localizada nesta região, conforme se pode observar na Fig. 1. A deformação deste componente ocorreu, claramente, no plano vertical perpendicular à asa, resultando de um esforço de flexão actuante neste plano e no sentido descendente, i.e., do extradorso para o intradorso.

Fig. 1 – Estado de deformação da longarina principal da asa direita junto à raiz.

Perante esta observação, levantou-se a hipótese de este esforço de flexão poder ter ocorrido em voo, o que, a acontecer, poderia ter origem em dois cenários distintos: em resultado de uma sobrecarga associada a uma manobra ou devido a uma falha estrutural provocada por fadiga do material. De modo a averiguar a validade desta última hipótese, decidiu-se efectuar uma análise aprofundada da superfície de fractura

da longarina através da utilização de um microscópio óptico. A Fig.2 apresenta a imagem geral da superfície de fractura, enquanto a Fig.3, dividida em 8 partes, analisa, com maior detalhe, toda a extensão desta superfície. Através da observação destas imagens, não se conseguiu detectar quaisquer indícios de danos provocados por mecanismos de fadiga, os quais, habitualmente, e para este tipo de material, apresentam zonas claras de propagação da(s) fenda(s), com origem num local de nucleação, dando origem a marcas de deformação plástica cíclica (estrias) reveladoras do fenómeno. Ao invés, a superfície de fractura da longarina da asa tem uma morfologia idêntica em toda a sua secção transversal, sendo visíveis marcas de forte deformação plástica que resultaram, muito provavelmente, da aplicação de uma carga acima do valor limite admissível pelo material.

Outro aspecto importante relativo a este componente diz respeito à presença de vestígios de terra e palha incrustados na superfície de fractura, como se pode facilmente ver nas imagens da Fig. 3. Para além disso, a Fig. 4 permite constatar que uma das mesas (banzos) da longarina apresenta marcas de raspagem alinhadas paralelamente entre si. Estes dois factos, demonstram que a raiz da asa terá sido o ponto de impacto com o solo, podendo isso ter contribuído para o elevado esforço de flexão aí verificado.

Fig. 2 – Superfície de fractura da longarina principal da asa.

A asa direita apresenta um estado limitado de deformação generalizada (observe-se a Fig. 5), parecendo indicar que esta ter-se-ia soltado antes de ter embatido com o solo. Há, apenas, a salientar uma deformação ligeira do intradorso junto à ponta de asa, o

qual apresenta marcas de instabilidade estrutural, em forma de vincos (ou rugas) orientados a cerca de 45º, como se vê na Fig. 6. Este tipo de deformação da estrutura está, habitualmente, associado a esforços de corte no revestimento que resultam, por sua vez, de cargas de torção aplicadas à asa.

(a) (b)

(c) (d)

(e) (f)

Fig. 3 – Observação detalhada da superfície de fractura da longarina da asa considerando uma divisão da mesma em 8 regiões distintas.

Fig. 4 – Imagem de marcas de raspagem localizadas numa das mesas da longarina principal da asa.

Por seu turno, a asa esquerda apresenta um nível de deformação generalizada superior, embora, neste caso, não se tenha verificado um esforço de flexão tão acentuado na longarina principal, tal como se pode observar nas imagens da Fig. 7. Apesar disso, a asa foi encontrada no local do acidente partida em duas secções, as quais se separaram numa estação próxima da zona de fixação com o motor (ver Fig. 7a) e Fig. 8). No caso desta superfície alar, o berço do motor foi encontrado ainda acoplado à estrutura da asa.

Fig. 5 – Estado geral de deformação da asa direita.

Fig. 6 – Presença de marcas de instabilidade estrutural no revestimento do intradorso da asa direita, junto à ponta de asa.

(a) (b)

Fig. 7 - a) Estado geral de deformação da asa esquerda; b) pormenor da deformação da longarina da asa esquerda junto à raiz.

Fig. 8 – Imagem da ponta de asa esquerda e do flap esquerdo.

3.2 - Análise do sistema de flaps

O flap da asa esquerda foi um dos componentes que mereceu maior atenção por ter sido o primeiro componente a ser encontrado, em termos de disposição espacial, no local do acidente. O estado geral em que este componente foi encontrado pode ser observado através da Fig. 8. Como se constata, o flap foi encontrado desacoplado da asa e partido em três secções distintas. Segundo uma informação fornecida pelo GPIAA, o fabricante da aeronave recomenda uma inspecção a este componente a cada 200 horas, tendo em vista a determinação de possíveis focos de corrosão galvânica na zona das articulações e apoios do flap. Assim sendo, decidiu-se inspeccionar este componente para avaliar a possibilidade de danos por corrosão que levassem à sua falha catastrófica. Das análises microscópicas efectuadas, não foi detectado qualquer vestígio de corrosão no dito componente, pelo que se poderá afastar esta hipótese de modo de ruína.

No entanto, o estado de deformação dos apoios do flap permitem concluir que este componente foi, muito provavelmente, separado da asa durante o voo. A Fig. 9 ilustra de forma inequívoca os esforços de corte na vizinhança dos apoios do flap que levaram a que a chapa do revestimento fosse literalmente rasgada aquando da separação deste componente.

De facto, o nível de esforços a que este componente esteve sujeito durante alguma fase do voo foi bastante significativo, como comprovam a generalidade das fracturas observadas nos pinos de articulação, sendo evidente que estas apresentam uma morfologia tipicamente associada a uma falha por esforços de corte, tal como visível na Fig. 10. Aliás, o efeito deste mesmo tipo de esforços foi também encontrado em todos os pontos de fixação das articulações, os quais são feitos com recurso a rebites.
Das imagens da Fig. 11, observa-se que a chapa na vizinhança dos rebites está rasgada e apresenta uma deformação fora do plano, o que corrobora a hipótese do flap ter sido arrancado da asa devido a um esforço súbito e de grande intensidade. Por outro lado, nas várias observações efectuadas a este componente, não foram detectadas quaisquer evidências de mecanismos de deformação plástica cíclica devido a fadiga.

Finalmente, na sequência de uma visita às instalações da Academia Aeronáutica de Évora, onde se avaliou, in loco, o sistema de accionamento do flap, foi decidido proceder à observação minuciosa do actuador do flap, em concreto, do parafuso sem-fim acoplado ao motor de accionamento desta superfície. Este sistema de accionamento pode ser visualizado na Fig. 12. A observação deste parafuso através de uma lupa microscópica não permitiu detectar quaisquer indícios de marcas que pudessem sugerir uma sobrecarga actuante neste componente. Todavia, constatou-se que este parafuso estaria completamente estendido, i.e., na posição extrema de accionamento, o que corresponderá à posição de flaps recolhidos. A análise posterior de todo o sistema de accionamento dos flaps visível na Fig. 12 (o qual, para além dos já referidos motor de accionamento e parafuso sem-fim, é também constituído por um tubo de torção acoplado aos flaps e por um guinhol - braço de comando – de fixação ao parafuso) revelou que o braço de comando de fixação apresentava uma acentuada

deformação no sentido da asa esquerda, como se poderá visualizar com maior detalhe na Fig. 13.

Fig. 9 – Flap da asa esquerda, com sinais evidentes de arrancamento na zona de fixação à asa, junto aos apoios e articulações.

Fig. 10 – Superfície de fractura de um dos pinos de articulação do flap da asa esquerda.

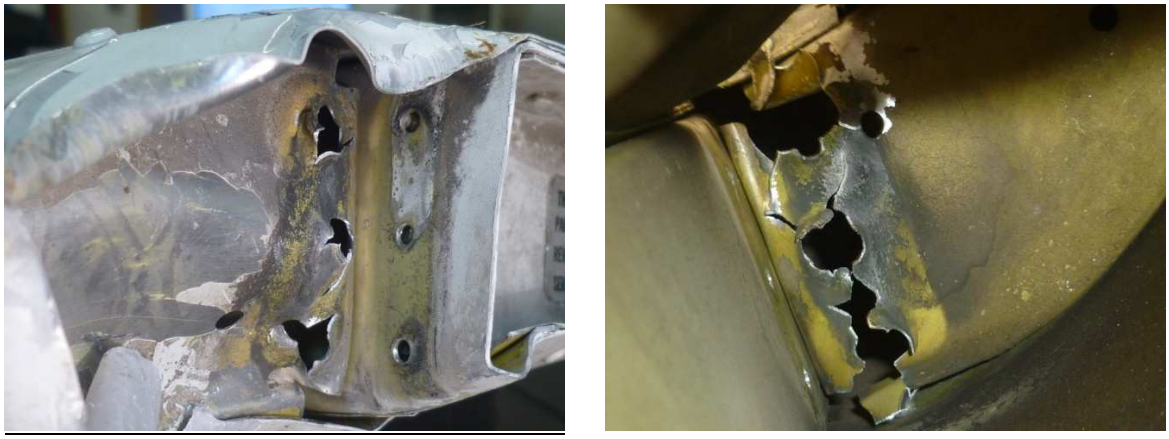


Fig. 11 – Dois exemplos de esforços de corte devido a arrancamento na vizinhança dos rebites das zonas de fixação do flap

Fig. 12 – Sistema de accionamento dos flaps instalado na zona central da fuselagem.

Fig. 13 – Pormenor do estado de deformação da ferragem de fixação do parafuso sem-fim ao tubo de torção de accionamento dos flaps.

Também, da Fig.13 se pode igualmente concluir que o tubo de torção se deslocou no sentido da asa esquerda, facto visível pela zona de diferente aspecto superficial (mais limpo) à esquerda do mancal de suporte visível na imagem. Este movimento do tubo de accionamento dos flaps parece contrariar o tipo de deformação verificada na ferragem de fixação ao parafuso sem-fim. No entanto, durante a visita efectuada à Academia Aeronáutica de Évora, houve oportunidade de observar um sistema idêntico pertencente a uma aeronave semelhante, tendo sido constatado que esta ferragem, em condições normais, está montada com um ligeiro desalinhamento para a esquerda em relação ao parafuso sem-fim (veja-se a Fig.14). Ora, este desalinhamento pode provocar uma componente de força coerente com a deformação detectada no guinhol da aeronave acidentada face à aplicação de um elevado momento de torção no tubo de accionamento dos flaps. Para que este momento atinja um valor significativamente elevado e suficiente para causar tal deformação, é provável que se tenha verificado uma carga actuante nos flaps acima do valor de projecto para este tipo de sistema. Finalmente, o tubo de torção usado para accionamento dos flaps foi encontrado partido na zona central da fuselagem e junto à raiz da asa direita. O aspecto da superfície de fractura é aquele visível na Fig. 15. Como se observa, o tubo apresenta indícios de deformações causadas por esforços de compressão, resultando numa instabilidade localizada nas paredes do tubo na vizinhança da zona de fractura.

Fig. 14 – Pormenor do desalinhamento da ferragem de fixação da rótula do parafuso sem-fim ao tubo de torção de accionamento dos flaps num avião idêntico observado na Academia Aeronáutica de Évora.

Fig. 15 – Deformação do tudo de accionamento dos flaps na zona de fractura.

3.3 – Cauda da aeronave

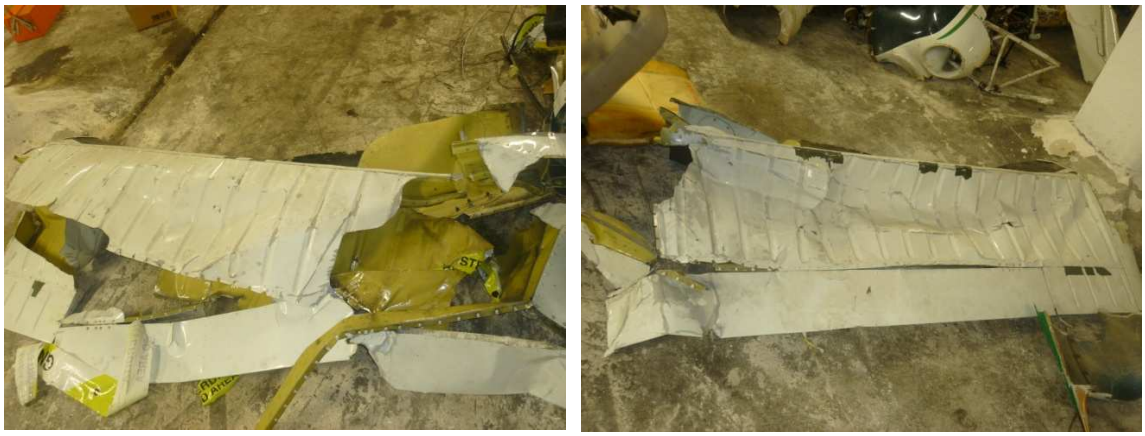
A análise efectuada à cauda da aeronave incidiu, essencialmente, em dois aspectos principais: 1) ao estado do leme de profundidade e respectivo compensador; 2) ao estado geral do leme vertical e respectivo estabilizador. Note-se que, apesar destas

duas partes principais da cauda terem sido encontradas acopladas entre si no local do acidente, o conjunto encontrava-se, porém, destacado da restante aeronave, em virtude de uma fractura generalizada na secção do cone de cauda.
Começando pelo leme de profundidade, a primeira constatação evidente resultante da observação directa dos destroços da aeronave prende-se com o elevado estado de deformação generalizada deste componente, conforme se poderá avaliar através da imagem da Fig. 16. Efectivamente, o revestimento metálico desta superfície evidencia uma forte deformação no sentido descendente (i.e., do extradorso para o intradorso) em torno da longarina principal, tal como se vê na Fig. 17. Não nos parece plausível que este tipo de deformação tenha ocorrido em virtude de qualquer impacto desta superfície com o solo, até porque são escassas as marcas de sujidade ou a presença de elementos do terreno que apoiassem esta hipótese. Ao invés, o tipo de deformação do revestimento aponta para um carregamento uniformemente distribuído ao longo da envergadura da superfície horizontal, muito provavelmente devido a um elevado esforço aerodinâmico de aplicação súbita. O facto da deformação ter ocorrido de cima para baixo, faz crer que o movimento que esteve na sua origem se desenvolvesse no sentido oposto, i.e., de baixo para cima. Note-se que o tipo de estrutura interna do leme de profundidade é bastante simples, com poucos elementos de reforço, pelo que a aplicação de um factor de carga elevado poderá induzir uma forte deformação neste componente devido à sua rigidez limitada em condições de solicitação mecânica para além do ponto de projecto.

Fig. 16 - Estado geral de deformação da cauda da aeronave (leme de profundidade, leme de direcção e estabilizador vertical).

Fig. 17 – Deformação do revestimento do leme de profundidade em torno da longarina principal.

Ainda relativamente à superfície horizontal, observou-se que o compensador apresentava um elevado estado de deformação no lado esquerdo da aeronave, apesar de se manter ainda, em parte, acoplado ao leme de profundidade (veja-se a Fig. 18).
Outro aspecto importante diz respeito à posição do actuador do compensador, do tipo parafuso sem-fim, tendo-se verificado que este estaria na posição de extensão total, conforme ilustra a imagem da Fig. 19. Esta posição do actuador corresponde à condição de compensador completamente em baixo, i.e., no limite do seu curso de movimentação.



(a) (b)

Fig. 18 – Estado de deformação do compensador e leme de profundidade: a) secção esquerda; b) secção direita.

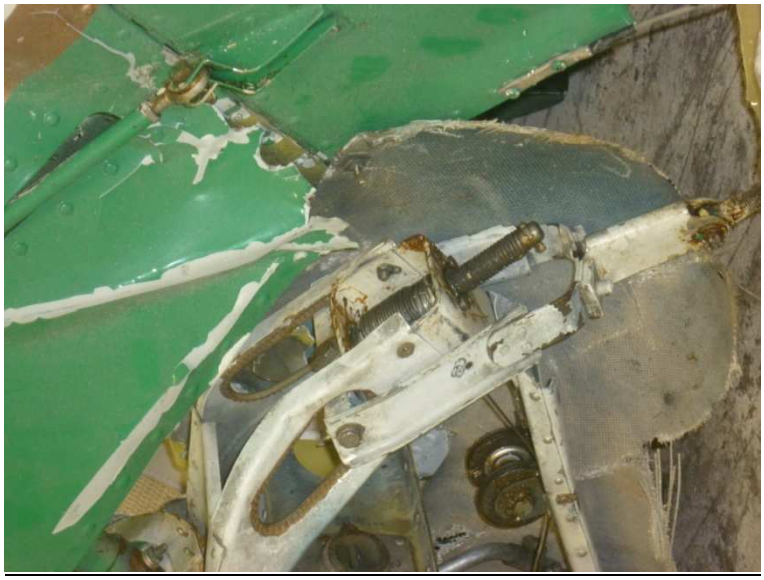


Fig. 19 – Pormenor relativo à posição do actuador do compensador do leme de profundidade.

Finalmente, a análise à empenagem vertical (leme e estabilizador) revelou que o nível de danos generalizado era, em termos comparativos, inferior ao da empenagem horizontal. De facto, o leme de direcção foi encontrado acoplado à longarina principal do estabilizador vertical, com preservação do seu tirante de accionamento, como se vê na Fig. 20. No entanto, a sua parte superior (*horn*), assim como a quase totalidade da carenagem frontal do leme vertical foram encontradas à parte no local dos destroços. Por outro lado, a zona de fixação da empenagem vertical à estrutura de suporte no cone de cauda evidenciava deformações e fracturas por esforços de corte na vizinhança de alguns rebites e parafusos de fixação.

Fig. 20 – Imagem da empenagem vertical (leme de direcção e compensador).

4. Conclusões

Devido à significativa dimensão dos estragos verificados na estrutura da aeronave acidentada, a investigação realizada no âmbito deste relatório procurou, no imediato, atender às solicitações feitas pelo GPIAA ao nível do estudo particular de alguns componentes, nomeadamente, asas e superfícies de comando da aeronave.
Das observações efectuadas pode-se concluir, em sentido lato, que existem fortes indícios de se ter verificado uma falha estrutural em voo, a qual afectou diversos componentes. Esta falha catastrófica ocorreu, provavelmente, por se terem excedido as cargas admissíveis pela estrutura (ou seja, aquelas previstas pelo diagrama n-V da aeronave). Tal circunstância poderá ter sido originada, em hipótese, pelo accionamento inadvertido e súbito de alguma superfície de comando aquando da condição de velocidade de cruzeiro, com especial relevância nos flaps ou leme/compensador de profundidade. Estas superfícies e os seus pontos de fixação à estrutura da aeronave não estão dimensionados para suportarem os esforços aerodinâmicos decorrentes do seu accionamento para este regime de velocidade. Por outro lado, a sua desintegração em voo resultará, por certo, na perda de controlo da aeronave, tornando hercúleos os esforços empreendidos pelo piloto para a sua recuperação face a atitudes de voo anormais.

Saliente-se, ainda, que, das análises efectuadas, não foi possível constatar quaisquer indícios de modos de ruína intrínsecos ao próprio material da estrutura, designadamente, fadiga e corrosão.

Finalmente, os autores deste relatório salientam o facto das peritagens efectuadas estarem, ainda assim, bastante aquém da extensão e nível de profundidade desejáveis para um acidente com esta dimensão. Assim, os trabalhos descritos neste relatório não cobrem a totalidade dos componentes onde se verificou algum indício de dano, pelo que muito mais haveria a fazer a este nível. Sugere-se, pois, que, caso seja considerado oportuno por parte do GPIAA, se estendam os esforços de análise à estrutura a outros componentes não cobertos pelos trabalhos descritos neste relatório, como, por exemplo, o berço e apoios dos motores da aeronave, ou outros que sejam considerados pertinentes.

Covilhã e UBI, 22 de Julho de 2010.

Os autores do relatório,

José Miguel Almeida da Silva
Doutor em Engenharia Aeroespacial
Professor Auxiliar do DCA (Ponto de contacto com o GPIAA)

Pedro Vieira Gamboa
Doutor em Engenharia Aeronáutica
Professor Auxiliar do DCA

Annex F – Report of the expert examination to aircraft engines

Teledyne Continental Motors, Inc.
A Teledyne Technologies Company

ENGINE EXAMINATION REPORT

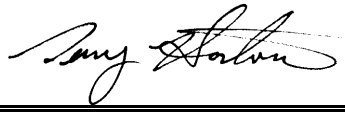
ENGINE MODEL: TSIO360RB

ENGINE SERIAL: 819282

AIRCRAFT MODEL: Piper PA-34-220T Seneca V

SERIAL NUMBER: 34-49089

REGISTRATION: OO-TML

Examiner	Signature	Date
Terry L Horton		April 27, 2010

GENERAL INFORMATION

EXAMINATION		ENGINE RECEIVED	
Date	April 27, 2010	Date	February 2, 2010
Facility	Teledyne Continental Motors	RGA #	1009-819532-R
Address	2039 Broad Street	FROM	AAE-CAE Global Academy, Evora Portugal
City	Mobile	NTSB/FAA Tagged	No
State and Zip	Alabama 36615	Box Sealed	Yes

ENGINE INFORMATION

Make	Teledyne Continental Motors
Model	TSIO369RB
Serial No.	819282
Engine Position	Left
Total Time	1202.08
Time SOH	NA
Build Date	5/22/2007
In Service Date	Unknown
Removal Date	9/15/2009

AIRCRAFT / ACCIDENT INFORMATION

Aircraft Make	Piper
Aircraft Model	PA-34-220T Seneca V
Aircraft Serial No.	34-49089
Registration No.	OO-TML
Accident Date	9/15/2009
Accident Location	Verde, Portugal

Significant logbook information: The log books were not available at the time of the teardown examination.

Report Summary: **Search Code:** 15-12-68

The inspection of this engine did not reveal any pre-impact abnormalities that would have prevented normal operation and production of rated horsepower.

Disposition of engine following exam: Engine was shipped on June 7, 2010 to:

CAE Global Academy, AAE

ATTN: Jose Costa

Aerodromo Municipal De Evora

Evora, Portugal 7000-790

Inspection Witnesses			
Inspector	Terry L Horton	Mechanic	Johnny Little
Address	2039 Broad Street, Mobile, Alabama, 36615	Address	2039 Broad Street, Mobile, Alabama, 36615
Organization	Teledyne Continental Motors	Organization	Teledyne Continental Motors
Phone No	251-436-8481	Phone No	251-436-8482
Witness	John T. Kent	Mechanic	Gregory Eastburn
Address	2039 Broad Street Mobile, Alabama 36615	Address	2039 Broad Street, Mobile, Alabama, 36615
Organization	251-436-8236	Organization	Teledyne Continental Motors
Phone No		Phone No	251-436-8482
Witness	Jason Aguilera		
Address	4760 Oakland Street, Suite-500 Denver, Colorado 80239		
Organization	NTSB		
Phone No	303-373-3504		

EXTERNAL INSPECTION OF ENGINE: The engine exhibited impact damage and the turbocharger, both magnetos, the vacuum pump, and the alternator were separated.

AIRFRAME PARTS RETURNED WITH ENGINE: Portions of control cables, air conditioning compressor, cooling baffles, propeller governor, de-ice block, fuel lines, and miscellaneous hoses and wiring.

ENGINE COMPONENT EXAMINATION

Exhaust System

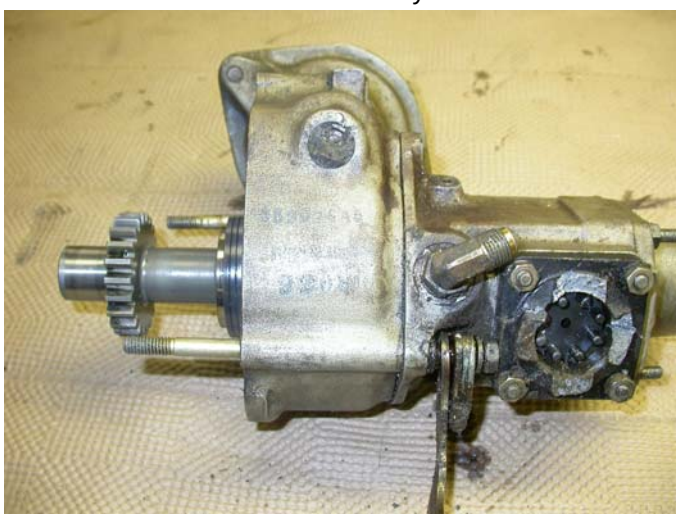
Condition: The exhaust system components were already disassembled and exhibited impact damage.

Starter Manufacturer: Iskra Part Number: 655566 Serial #: 07 23 0114

Condition: The starter rotated by hand and was intact and exhibited impact damage.

Starter Adapter Part Number: 653074A5 Lot: 9208

Condition: The starter rotated by hand and was intact and had impact damage.



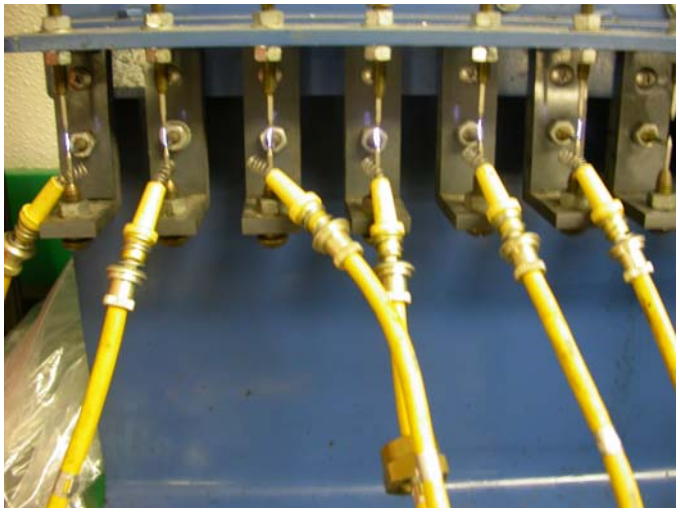
Crankshaft to Camshaft Timing The crankshaft to camshaft timing was verified by the alignment of the gear's timing marks.

Ignition Harness Manufacturer: TCM Model/Part Number: Not Marked Serial #: Not Marked

Condition: The ignition harness had impact damage and several of the wires were cut and frayed.

L/H Magneto Manufacturer: Slick Model/Part Number: 6324 Serial #: 06103161

Condition: The left-hand magneto turned freely with impulse coupling engagement. The magneto was installed and tested on the test bench and produced a blue spark across a 7 mm gap through the full range of test bench RPM. The magneto had impact damage on the mounting flange.



R/H Magneto Manufacturer: Slick Model/Part Number: 6324 Serial #: 05011175

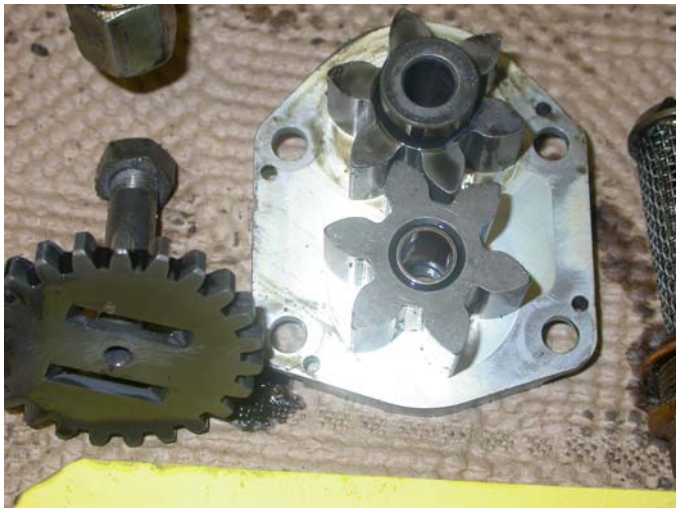
Condition: The right-hand magneto would not rotate. It was disassembled and the points were impact damaged. The magneto also had impact damage on the mounting flange.

Oil Cooler Manufacturer: Niagara Model/Part Number: 204558A Serial #: K06-4776-526

Condition: The oil cooler was undamaged and exhibited normal operating signatures.

Oil Pump

Condition: The oil pump drive was intact. The oil pump cavity contained light scratches and exhibited normal operating signatures. The oil pump gear teeth exhibited normal operating signatures. The oil pressure relief valve and seat contained no obstructions and exhibited signatures of proper seating.

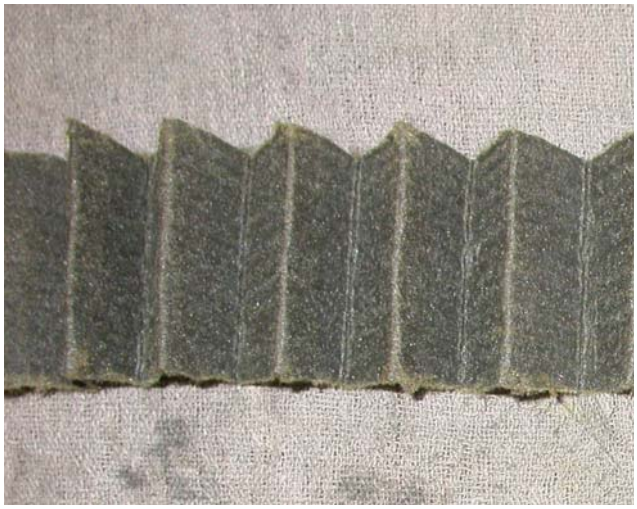


Oil Filter / Screen

Manufacturer: Champion

Part number: CH-48108-1

Condition: The oil filter housing was cut open using the Champion cutting tool and the filter element was cut from the canister to allow examination. The oil filter element was coated with oil. No metal particles were observed in the filter element.



Throttle and Servo Assembly Manufacturer: Precision RSA-5AD2 Part Number : Illegible Serial #: 70BN0605

Condition: The fuel control unit was in place on the engine and exhibited impact damage.

Fuel Pump Manufacturer: TCM Part Number: 654351-4A1 Serial #: B07EA052R

Condition: The fuel pump drive shaft turned freely and there were no abnormalities present. The fuel pump drive was intact and undamaged. The pump was disassembled and no internal damage was observed.

Fuel Manifold Valve Manufacturer: TCM Part Number: 652432-5A4 Serial #: C07EA064R

Condition: The fuel manifold valve exhibited normal operating signatures. The manifold valve was disassembled to examine the internal components. The manifold valve plunger assembly was intact, secure and undamaged. There were no signatures of fuel stains or leakage in the vent chamber side of the diaphragm.

Fuel Nozzles and Lines Manufacturer: TCM

Position	#1	#3	#5	#2	#4	#6
Size	13B	13B	13B	13B	13B	13B

Condition: The fuel nozzles were unrestricted and exhibited normal operating signatures. The fuel lines were separated and impact damaged.

Spark Plugs Manufacturer: Champion Part number: RHM-38E

Condition: The number two top spark plug was missing. The remaining top and bottom sparkplugs had normal wear signatures in accordance with the Champion aviation check-a-plug comparison chart. The number two top spark plug was later located and it had normal wear signatures.

Alternator Manufacturer: N/A Part Number: N/A Serial #: N/A

Condition: The alternator was not returned with the engine.

Oil Sump Condition: The oil sump was undamaged and exhibited normal operating signatures. The oil sump was drained and a small amount of oil was recovered. The oil was dark in color.

Oil Pick-up Tube & Screen Condition: The oil pick-up tube was undamaged. The oil suction screen was unrestricted.

Induction System Condition: The induction system had heavy impact damage and was mostly crushed.

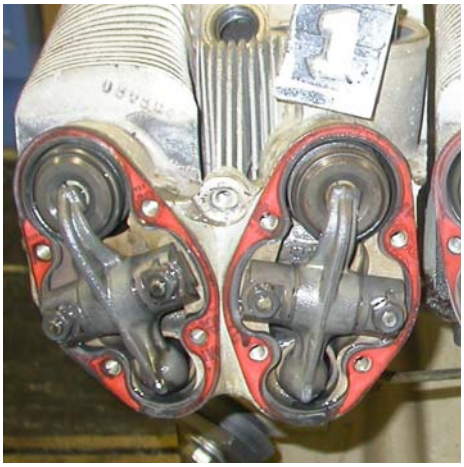
Aftercooler Part number: N/A Serial Number: N/A

Condition: The aftercooler was not returned with the engine.

Cylinder #1 Part Number: 655479A11 Head Date: 8/08 Barrel Surface: Steel

Serial #: AC08EA945 Work Order Numbers: None

Condition: The spot putty was not evident on the cylinder hold-down nuts. The cylinder combustion chamber had a normal amount of combustion deposits and the bore condition was free of scoring and undamaged. The cylinder skirt was intact and undamaged and there were no hone marks visible in the cylinder bore ring travel area. The intake and exhaust valve heads exhibited normal deposits and operating signatures. The rocker box area had an oil residue indicating lubrication to the overhead. The cylinder overhead components (valves, rocker arms, guides, springs, retainers and shafts) were lubricated and undamaged.



Cylinder #2 Part Number: 655479A11 Head Date: 3/07 Barrel Surface: Steel

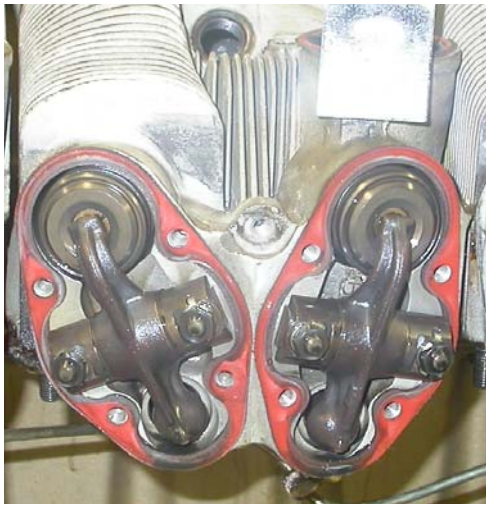
Serial #: AC07BB108 Work Order Numbers: None

Condition: The spot putty was not evident on the cylinder hold-down nuts. The cylinder combustion chamber had a normal amount of combustion deposits and the bore condition was free of scoring and undamaged. The cylinder skirt was intact and undamaged and there were no hone marks visible in the cylinder bore ring travel area. The intake and exhaust valve heads exhibited normal deposits and operating signatures. The rocker box area had an oil residue indicating lubrication to the overhead. The cylinder overhead components (valves, rocker arms, guides, springs, retainers and shafts) were lubricated and undamaged.

Cylinder #3 Part Number: 655479A11 Head Date: 3/07 Barrel Surface: Steel

Serial #: AC07BB121 Work Order Numbers: None

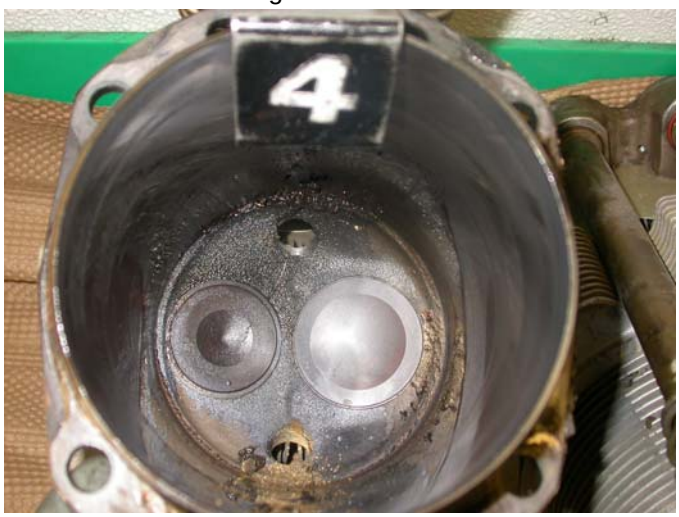
Condition: The spot putty was not evident on the cylinder hold-down nuts. The cylinder combustion chamber had a normal amount of combustion deposits and the bore condition was free of scoring and undamaged. The cylinder skirt was intact and undamaged and there were no hone marks visible in the cylinder bore ring travel area. The intake and exhaust valve heads exhibited normal deposits and operating signatures. The rocker box area had an oil residue indicating lubrication to the overhead. The cylinder overhead components (valves, rocker arms, guides, springs, retainers and shafts) were lubricated and undamaged.



Cylinder #4 Part Number: 655479A11 Head Date: 3/07 Barrel Surface: Steel

Serial #: AC07BB089 Work Order Numbers: None

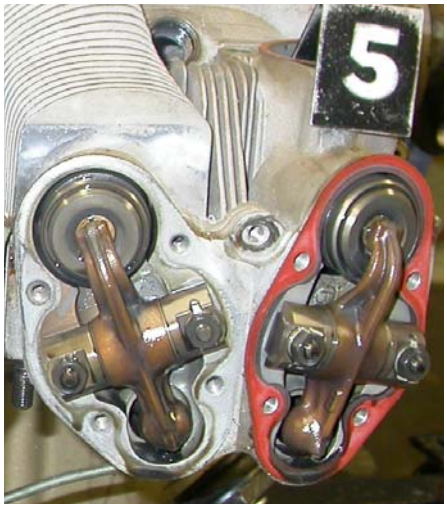
Condition: The spot putty was not evident on the cylinder hold-down nuts. The cylinder combustion chamber had a normal amount of combustion deposits and the bore condition was free of scoring and undamaged. The cylinder skirt was intact and undamaged and there were no hone marks visible in the cylinder bore ring travel area. The intake and exhaust valve heads exhibited normal deposits and operating signatures. The rocker box area had an oil residue indicating lubrication to the overhead. The cylinder overhead components (valves, rocker arms, guides, springs, retainers and shafts) were lubricated and undamaged.



Cylinder #5 Part Number: 655479A11 Head Date: 4/07 Barrel Surface: Steel

Serial #: AC07CB964 Work Order Numbers: None

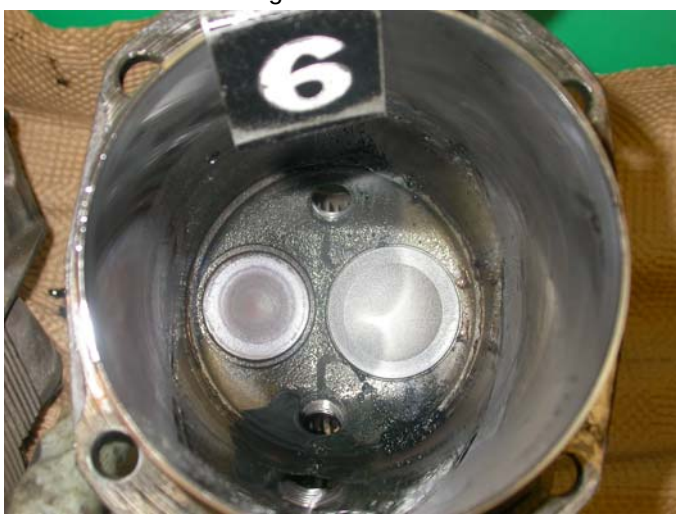
Condition: The spot putty was not evident on the cylinder hold-down nuts. The cylinder combustion chamber had a normal amount of combustion deposits and the bore condition was free of scoring and undamaged. The cylinder skirt was intact and undamaged and there were no hone marks visible in the cylinder bore ring travel area. The intake and exhaust valve heads exhibited normal deposits and operating signatures. The rocker box area had an oil residue indicating lubrication to the overhead. The cylinder overhead components (valves, rocker arms, guides, springs, retainers and shafts) were lubricated and undamaged.

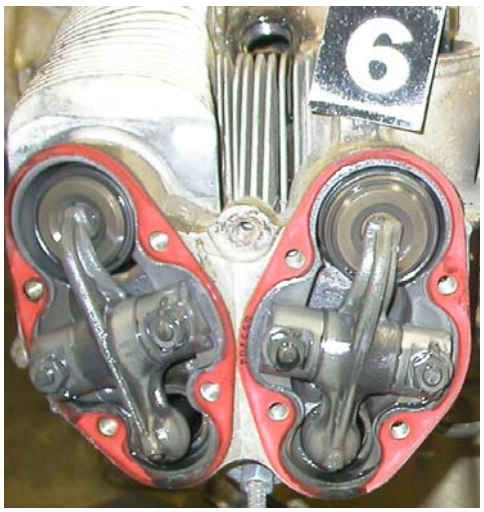


Cylinder #6 Part Number: 655479A11 Head Date: 4/07 Barrel Surface: Steel

Serial #: AC07CB942 Work Order Numbers: None

Condition: The spot putty was not evident on the cylinder hold-down nuts. The cylinder combustion chamber had a normal amount of combustion deposits and the bore condition was free of scoring and undamaged. The cylinder skirt was intact and undamaged and there were no hone marks visible in the cylinder bore ring travel area. The intake and exhaust valve heads exhibited normal deposits and operating signatures. The rocker box area had an oil residue indicating lubrication to the overhead. The cylinder overhead components (valves, rocker arms, guides, springs, retainers and shafts) were lubricated and undamaged.





#1 Piston, Rings and Pin Piston Part Number: 654859

Condition: The piston head exhibited a normal amount of combustion deposits and the piston skirt was free of scoring and damage. The piston rings were intact, free in their grooves, exhibited normal wear and operating signatures. The piston pin and plug assembly was intact and undamaged.

#2 Piston, Rings and Pin Piston Part Number: 654859

Condition: The piston head exhibited a normal amount of combustion deposits and the piston skirt was free of scoring and damage. The piston rings were intact, free in their grooves, exhibited normal wear and operating signatures. The piston pin and plug assembly was intact and undamaged.

#3 Piston, Rings and Pin Piston Part Number: 654859

Condition: The piston head exhibited a normal amount of combustion deposits and the piston skirt was free of scoring and damage. The piston rings were intact, free in their grooves, exhibited normal wear and operating signatures. The piston pin and plug assembly was intact and undamaged.

#4 Piston, Rings and Pin Piston Part Number: 654859

Condition: The piston head exhibited a normal amount of combustion deposits and the piston skirt was free of scoring and damage. The piston rings were intact, free in their grooves, exhibited normal wear and operating signatures. The piston pin and plug assembly was intact and undamaged.

#5 Piston, Rings and Pin Piston Part Number: 654859

Condition: The piston head exhibited a normal amount of combustion deposits and the piston skirt was free of scoring and damage. The piston rings were intact, free in their grooves, exhibited normal wear and operating signatures. The piston pin and plug assembly was intact and undamaged.

#6 Piston, Rings and Pin Piston Part Number: 654859

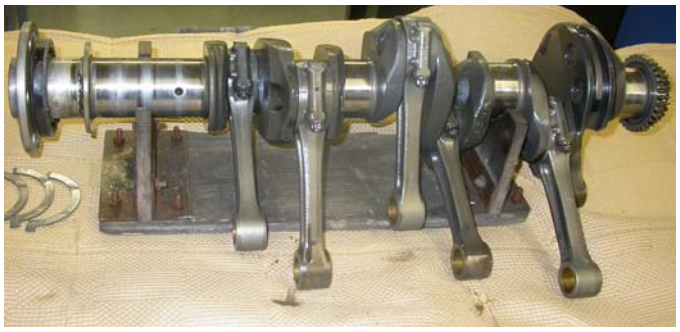
Condition: The piston head exhibited a normal amount of combustion deposits and the piston skirt was free of scoring and damage. The piston rings were intact, free in their grooves, exhibited normal wear and operating signatures. The piston pin and plug assembly was intact and undamaged.

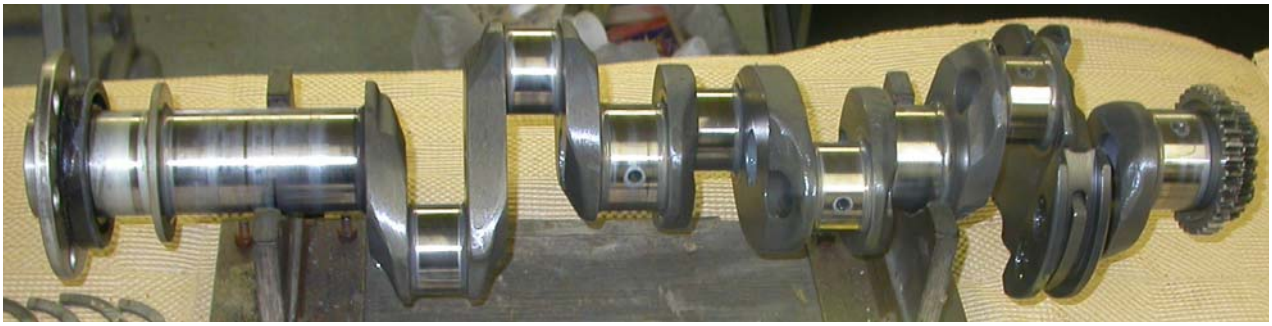
Lifter	#1	#3	#5	#2	#4	#6
Intake	653906	653906	653906	653906	653906	653906
Exhaust	653906	653906	653906	653906	653906	653906

Condition: The lifter faces were undamaged and exhibited normal operating signatures. The lifter bodies were undamaged and exhibited normal operating signatures.

Crankshaft Forging number: 649877 Serial number: N07CA309 Heat code: KLMC

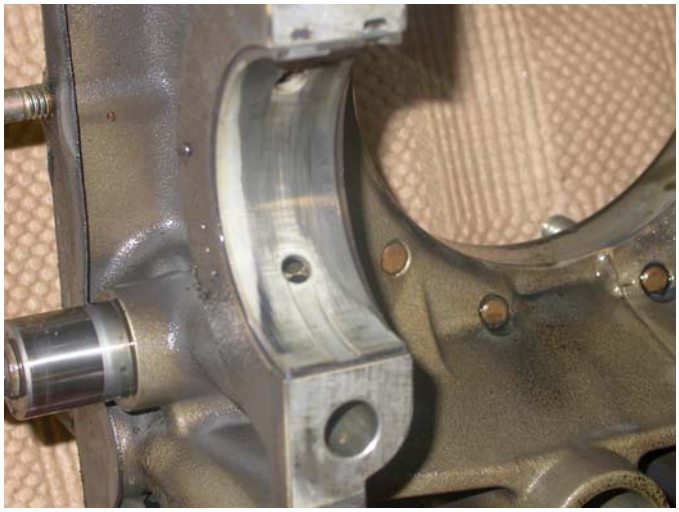
Condition: The crankshaft and counterweight assembly was undamaged and exhibited normal operating signatures. The connecting rod journals, main journals and thrust surfaces were undamaged and showed no signs of abnormal wear or lubrication distress. The crankshaft counterweight pins, plates and snap-rings were intact. The counterweights were undamaged and had free and unrestricted movement on the hanger blades.

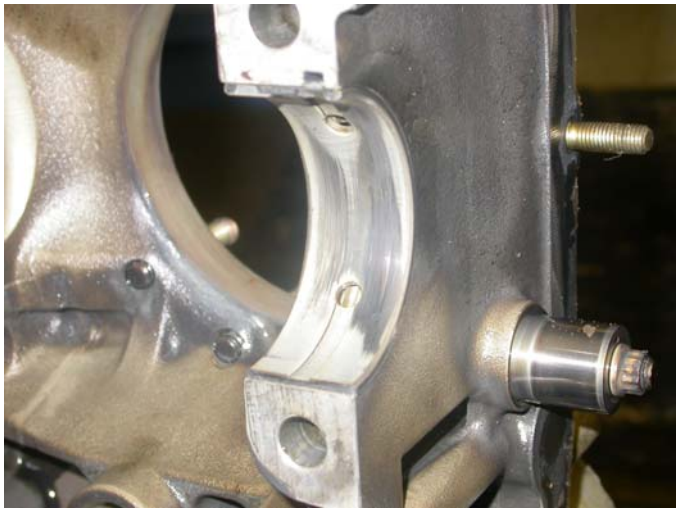




#1 Main Bearings Part #: 642337 Date Code: 02/07

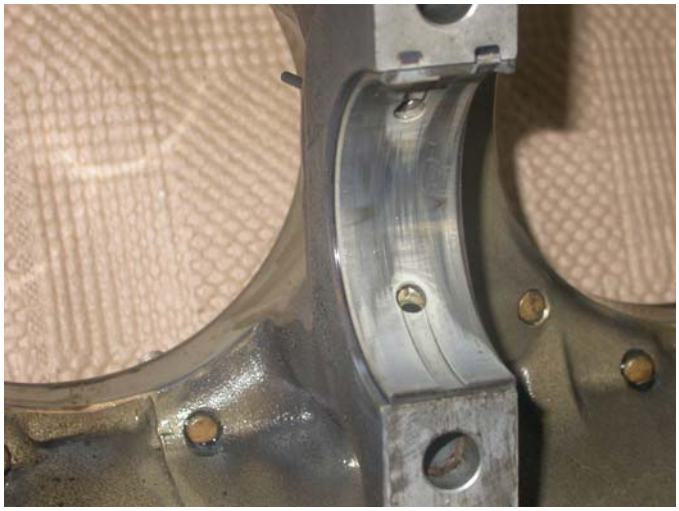
Condition The #1 (rear) crankshaft main bearings exhibited normal operating and lubrication signatures. The bearings were intact and exhibited an insignificant amount of contamination and hard particle passage. There were no signs of lubrication distress.





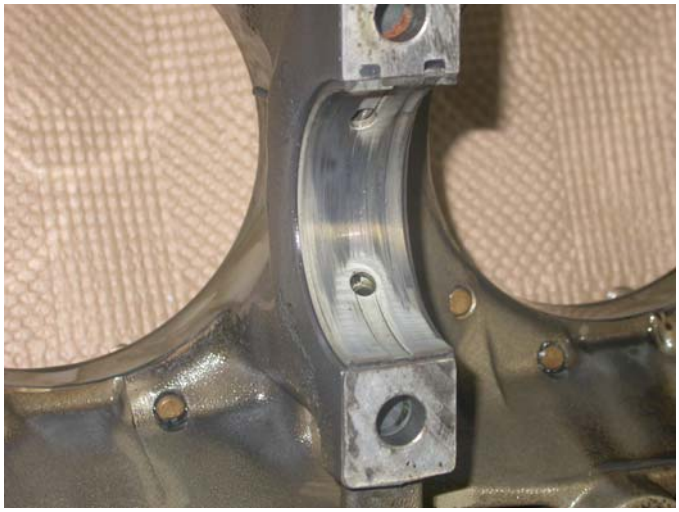
#2 Main Bearings Part #: 642337 Date Code: 02/07

Condition The #2 (intermediate) crankshaft main bearings exhibited normal operating and lubrication signatures. The bearings were intact and exhibited an insignificant amount of contamination and hard particle passage. There were no signs of lubrication distress.



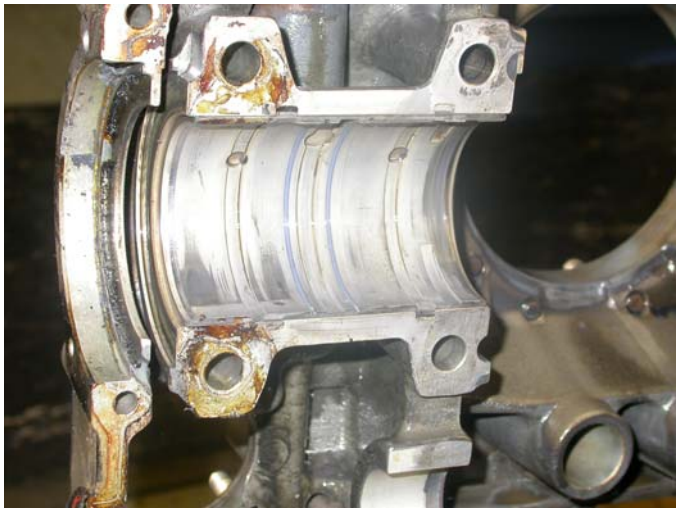
#3 Main Bearings Part #: 642337 Date Code: 02/07

Condition The #3 (intermediate) crankshaft main bearings exhibited normal operating and lubrication signatures. The bearings were intact and exhibited an insignificant amount of contamination and hard particle passage. There were no signs of lubrication distress.



#4 Main Bearings Part #: 641992 Date Code: 08/06

Condition The #4 (front) crankshaft main bearings exhibited normal operating and lubrication signatures. The bearings were intact and exhibited an insignificant amount of contamination and hard particle passage. There were no signs of lubrication distress.



#1 Connecting Rod Part #: 654793 Forging #: 646116 Serial #: AE07DA744

Condition: The connecting rod assembly was intact and undamaged. The connecting rod nuts and bolts were intact and secure. The connecting rod bushing exhibited normal operating and lubrication signatures.

#1 Connecting Rod Bearings Part #: 642338 Date Code: 8/06

Condition: The connecting rod bearing exhibited normal operating and lubrication signatures. The connecting rod bearings were intact and exhibited an insignificant amount of contamination and hard particle passage. There were no signs of lubrication distress.

#2 Connecting Rod Part #: 654793 Forging #: 646793 Serial #: AE07DA718

Condition: The connecting rod assembly was intact and undamaged. The connecting rod nuts and bolts were intact and secure. The connecting rod bushing exhibited normal operating and lubrication signatures.

#2 Connecting Rod Bearings Part #: 642338 Date Code: 8/06

Condition: The connecting rod bearing exhibited normal operating and lubrication signatures. The connecting rod bearings were intact and exhibited an insignificant amount of contamination and hard particle passage. There were no signs of lubrication distress.

#3 Connecting Rod Part #: 654793 Forging #: 646116 Serial #: AE07DA757

Condition: The connecting rod assembly was intact and undamaged. The connecting rod nuts and bolts were intact and secure. The connecting rod bushing exhibited normal operating and lubrication signatures.

#3 Connecting Rod Bearings Part #: 642338 Date Code: 8/06

Condition: The connecting rod bearing exhibited normal operating and lubrication signatures. The connecting rod bearings were intact and exhibited an insignificant amount of contamination and hard particle passage. There were no signs of lubrication distress.

#4 Connecting Rod Part #: 654793 Forging #: 646116 Serial #: AE07CB110

Condition: The connecting rod assembly was intact and undamaged. The connecting rod nuts and bolts were intact and secure. The connecting rod bushing exhibited normal operating and lubrication signatures.

#4 Connecting Rod Bearings Part #: 642338 Date Code: 8/06

Condition: The connecting rod bearing exhibited normal operating and lubrication signatures. The connecting rod bearings were intact and exhibited an insignificant amount of contamination and hard particle passage. There were no signs of lubrication distress.

#5 Connecting Rod Part #: 654793 Forging #: 646116 Serial #: AE07CB143

Condition: The connecting rod assembly was intact and undamaged. The connecting rod nuts and bolts were intact and secure. The connecting rod bushing exhibited normal operating and lubrication signatures.

#5 Connecting Rod Bearings Part #: 642338 Date Code: 8/06

Condition: The connecting rod bearing exhibited normal operating and lubrication signatures. The connecting rod bearings were intact and exhibited an insignificant amount of contamination and hard particle passage. There were no signs of lubrication distress.

#6 Connecting Rod Part #: 654793 Forging #: 646116 Serial #: AE07CB125

Condition: The connecting rod assembly was intact and undamaged. The connecting rod nuts and bolts were intact and secure. The connecting rod bushing exhibited normal operating and lubrication signatures.

#6 Connecting Rod Bearings Part #: 642338 Date Code: 8/06

Condition: The connecting rod bearing exhibited normal operating and lubrication signatures. The connecting rod bearings were intact and exhibited an insignificant amount of contamination and hard particle passage. There were no signs of lubrication distress.

Camshaft Part number: 655545D Serial Number: Z06KA301

Condition: The camshaft lobes exhibited normal operating signatures. The camshaft cluster gear was intact and exhibited normal operating signatures. The gear bolts were tight and saftied and the gear teeth were undamaged.

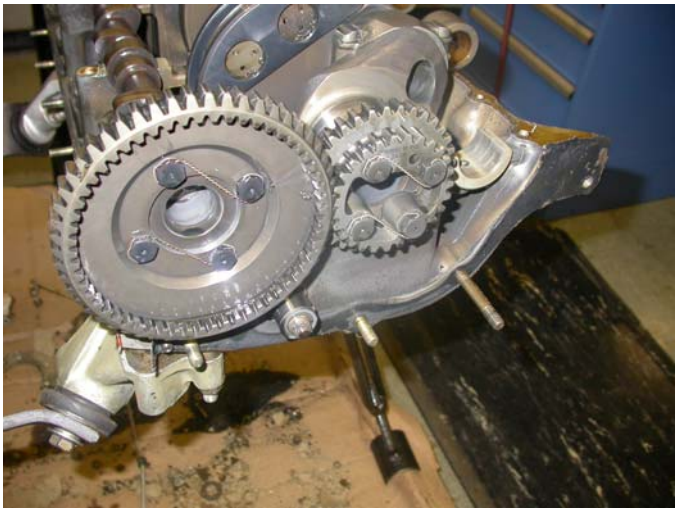
Crankcase Casting Number 1-3-5 Side 642333 2-4-6 Side: 642332 Serial number: S07BA038

Work Order Numbers: None

Condition: The crankcase exhibited minimal exterior damage. The cylinder bays were intact and undamaged. The main bearing support mating surfaces were intact and exhibited no signs of fretting or bearing tang lock-slot elongation. The main bearing support diameters were intact and exhibited no signs of bearing movement or rotation. The oil galleys and passages in the left and right crankcase halves were intact, clear and unrestricted.

Accessory Gears

Condition: The accessory gears had continuity. The teeth were undamaged and exhibited normal operating signatures.



Turbocharger

Part number: 649151-2 Kelly Aerospace TAO411 Serial Number: KDL00794

Condition: The turbocharger exhibited freedom of rotation by hand and no binding during the application of axial and end loading. The turbine housing was intact and there were no cracks or exhaust leaks present. The turbine blades were intact. The center housing oil inlet and outlet fittings were intact and there were no signatures of oil leakage. The center housing was intact and there were no cracks or exhaust leaks present. The compressor housing was intact and there were no cracks present. The compressor housing was attached securely to the center housing. The compressor blades were intact and they exhibited minimal erosion signatures.

Controller Part number: 633366-11 Serial Number: KAN00934

Condition: The controller exhibited impact damage and imbedded debris.

Wastegate Part number: 649006-8 Serial Number: KDN00477

Condition: The wastegate (exhaust by-pass) valve was in the full open position.

Propeller Governor Part number: D94315 Serial Number: 9#6515-SJ 07/07 OHC

Condition: The propeller governor could be rotated by hand, was intact and undamaged.

Vacuum Pump Part number: N/A Serial Number: N/A

Condition: The vacuum pump was not returned with the engine.

Teledyne Continental Motors, Inc.
A Teledyne Technologies Company

ENGINE EXAMINATION REPORT

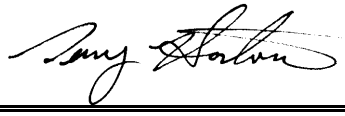
ENGINE MODEL: LTSIO360RB

ENGINE SERIAL: 819532

AIRCRAFT MODEL: Piper PA-34-220T Seneca V

SERIAL NUMBER: 34-49089

REGISTRATION: OO-TML

Examiner	Signature	Date
Terry L Horton		April 28, 2010

GENERAL INFORMATION

EXAMINATION		ENGINE RECEIVED	
Date	April 28, 2010	Date	February 2, 2010
Facility	Teledyne Continental Motors	RGA #	1009-819532-R
Address	2039 Broad Street	FROM	AAE-CAE Global Academy, Evora Portugal
City	Mobile	NTSB/FAA Tagged	No
State and Zip	Alabama 36615	Box Sealed	Yes

ENGINE INFORMATION

Make	Teledyne Continental Motors
Model	LTSIO360RB
Serial No.	819532
Engine Position	Right
Total Time	1202.08
Time SOH	NA
Build Date	5/25/2007
In Service Date	Unknown
Removal Date	9/15/2009

AIRCRAFT / ACCIDENT INFORMATION

Aircraft Make	Piper
Aircraft Model	PA-34-220T Seneca V
Aircraft Serial No.	34-49089
Registration No.	OO-TML
Accident Date	9/15/2009
Accident Location	Verde, Portugal

Significant logbook information: The log books were not available at the time of the inspection.

Report Summary: **Search Code:** 15-12-68

The inspection of this engine did not reveal any pre-impact abnormalities that would have prevented normal operation and production of rated horsepower.

Disposition of engine following exam: Engine was shipped on June 7, 2010 to:

CAE Global Academy, AAE

ATTN: Jose Costa

Aerodromo Municipal De Evora

Evora, Portugal 7000-790

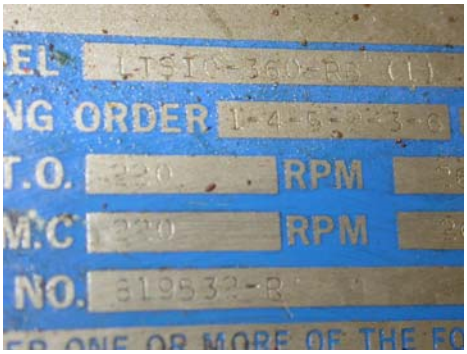
Inspection Witnesses			
Inspector	Terry L Horton	Mechanic	Johnny Little
Address	2039 Broad Street, Mobile, Alabama, 36615	Address	2039 Broad Street, Mobile, Alabama, 36615
Organization	Teledyne Continental Motors	Organization	Teledyne Continental Motors
Phone No	251-436-8481	Phone No	251-436-8482
Witness	John T. Kent	Mechanic	Gregory Eastburn
Address	2039 Broad Street Mobile, Alabama 36615	Address	2039 Broad Street, Mobile, Alabama, 36615
Organization	Teledyne Continental Motors	Organization	Teledyne Continental Motors
Phone No	251-436-8236	Phone No	251-436-8482
Witness	Jason Aguilera		
Address	4760 Oakland Street, Suite-500 Denver, Colorado 80239		
Organization	NTSB		
Phone No	303-373-3504		

EXTERNAL INSPECTION OF ENGINE: The engine exhibited impact damage, and the turbocharger, both magnetos, the vacuum pump, and the alternator were separated.









AIRFRAME PARTS RETURNED WITH ENGINE: Portions of control cables, cooling baffles, prop governor, vacuum pump flange, fuel flow transducer, breather tube/hose and related hardware, fuel lines and miscellaneous hoses and wiring.

ENGINE COMPONENT EXAMINATION

Exhaust System

Condition: The exhaust system components were already disassembled and exhibited impact damage.

Starter Manufacturer: Iskra Part Number: 655566 Serial #: 07 65 0074

Condition: The starter rotated by hand and was intact and exhibited impact damage.

Starter Adapter Part Number: Illegible. Date Code: Illegible.

Condition: The starter rotated by hand and was intact and had impact damage.

Crankshaft to Camshaft Timing The crankshaft to camshaft timing was verified by the alignment of the gear's timing marks.

Ignition Harness Manufacturer: TCM Model/Part Number: Not Marked Serial #: Not Marked

Condition: The ignition harness had impact damage and several of the wires were cut and frayed.

L/H Magneto Manufacturer: N/A Model/Part Number: N/A Serial #: N/A

Condition: The magneto was not returned with the engine.

R/H Magneto Manufacturer: Slick Model/Part Number: 6320 Serial #: 06061230

Condition: The magneto was separated from the engine and the case was partly crushed. The magneto was disassembled and the internal components were impact damaged. Records indicate this magneto to be installed originally in the right-hand position.

Oil Cooler Manufacturer: Niagara NDM Model/Part Number: 646880 Serial #: K06-4776-521

Condition: The oil cooler was undamaged and exhibited normal operating signatures.

Oil Pump Condition: The oil pump drive was intact. The oil pump cavity contained light scratches and exhibited normal operating signatures. The oil pump gear teeth exhibited normal operating signatures. The oil pressure relief valve and seat contained no obstructions and exhibited signatures of proper seating.

Oil Filter Manufacturer: Champion Part number: CH-48108-1

Condition: The oil filter housing was cut open using the Champion cutting tool and the filter element was cut from the canister to allow examination. The oil filter element was coated with oil. No metal particles were observed in the filter element.

Throttle and Servo Assembly Manufacturer: N/A Part Number: N/A Serial #: N/A

Condition: The fuel control was not returned with the engine.

Fuel Pump Manufacturer: TCM Part Number: 654351-3A1 Serial #: B07EA069R

Condition: The fuel pump turned freely and there were no abnormalities present. The fuel pump drive was intact and undamaged. The pump was disassembled and no internal damage was observed.

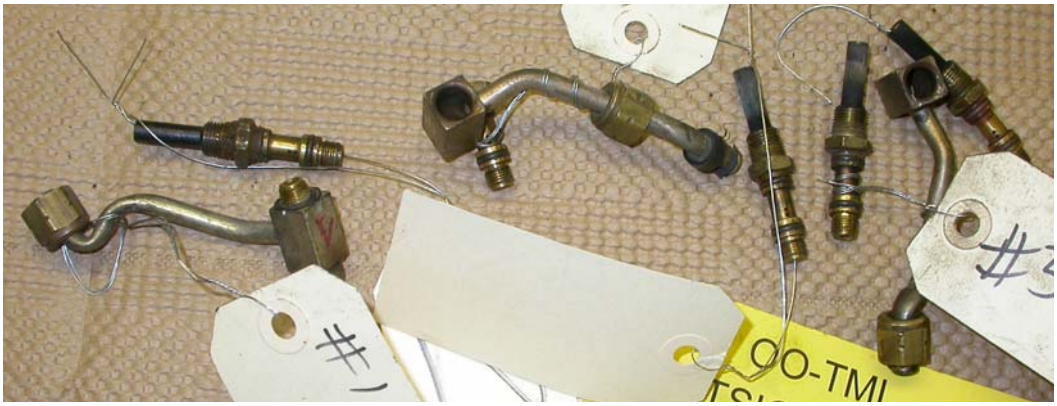
Fuel Manifold Valve Manufacturer: TCM Part Number: 652432-1A4 Serial #: C07EA072R

Condition: The fuel manifold valve exhibited normal operating signatures. The manifold valve was disassembled to examine the internal components. The manifold valve plunger assembly was intact, secure and undamaged. There were no signatures of fuel stains or leakage in the vent chamber side of the diaphragm.

Fuel Nozzles and Lines Manufacturer: TCM

Position	#1	#3	#5	#2	#4	#6
Size	13B	13B	13B	13B	13B	13B

Condition: The fuel nozzles were unrestricted and exhibited normal operating signatures. The fuel lines had heavy impact damage.



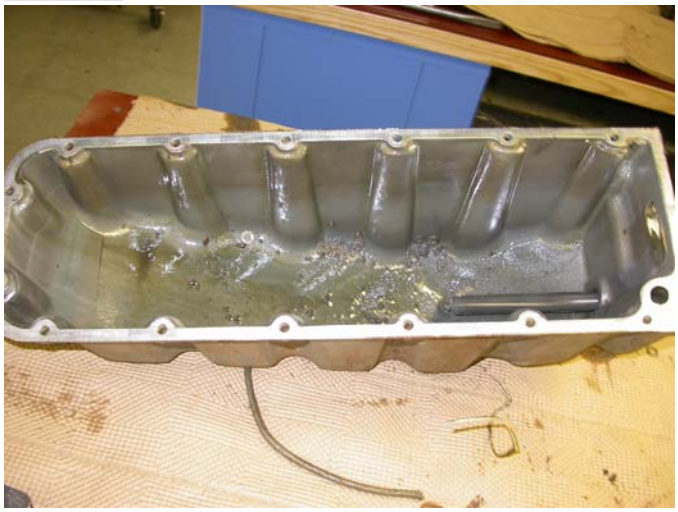
Spark Plugs Manufacturer: Champion RHM-38E

Condition: The top and bottom sparkplugs had normal wear signatures in accordance with the Champion aviation check-a-plug comparison chart.

Alternator Manufacturer: N/A Part Number: N/A Serial #: N/A

Condition: The alternator was not returned with the engine.

Oil Sump Condition: The oil sump was not damaged. A small amount of oil was drained from the sump.



Oil Pick-up Tube & Screen

Condition: The oil pick-up tube was undamaged. The oil suction screen was unrestricted.

Induction System

Condition: The induction system had heavy impact damage and was mostly crushed.

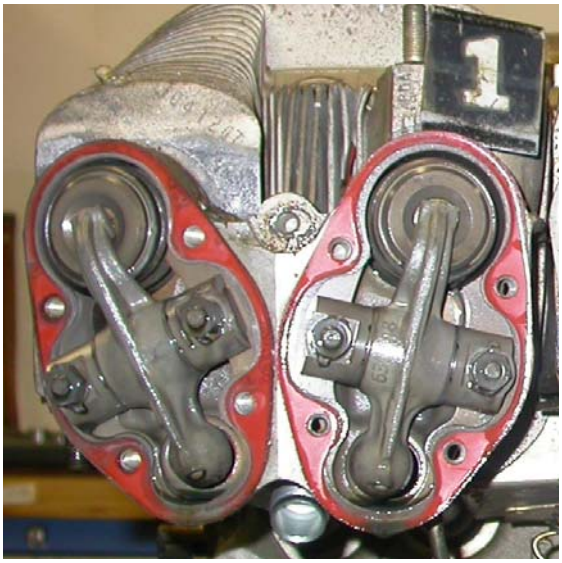
Aftercooler Part number: N/A Serial Number: N/A

Condition: The aftercooler was not returned with the engine.

Cylinder #1 Part Number: 655479A11 Head Date: 4/07 Barrel Surface: Steel

Serial #: A07CB979 Work Order Numbers: None

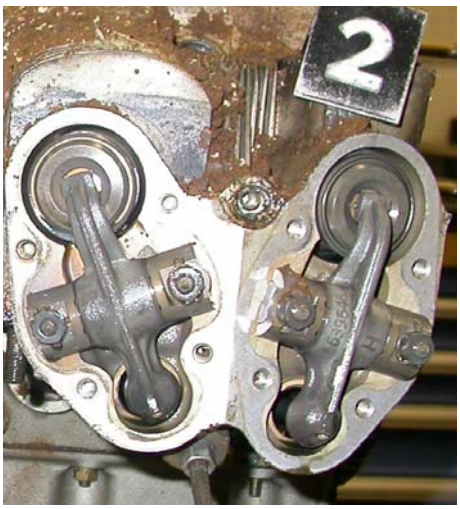
Condition: The spot putty was not evident on the cylinder hold-down nuts. The cylinder combustion chamber had a normal amount of combustion deposits and the bore condition was free of scoring and undamaged. The cylinder skirt was intact and undamaged and there were no hone marks visible in the cylinder bore ring travel area. The intake and exhaust valve heads exhibited normal deposits and operating signatures. The rocker box area had an oil residue indicating lubrication to the overhead. The cylinder overhead components (valves, rocker arms, guides, springs, retainers and shafts) were lubricated and undamaged.



Cylinder #2 Part Number: 655479A11 Head Date: 3/07 Barrel Surface: Steel

Serial #: AC07BB113 Work Order Numbers: None

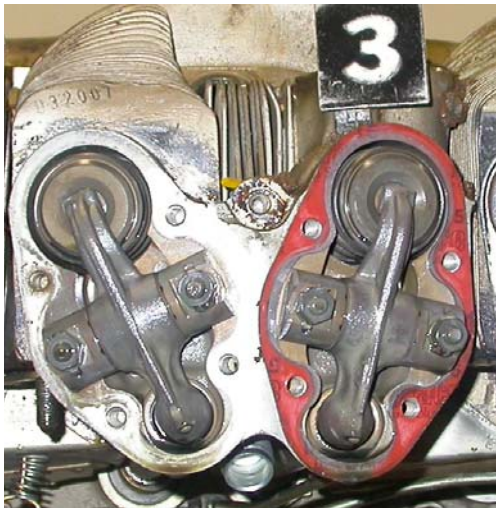
Condition: The spot putty was not evident on the cylinder hold-down nuts. The cylinder combustion chamber had a normal amount of combustion deposits and the bore condition was free of scoring and undamaged. The cylinder skirt was intact and undamaged and there were no hone marks visible in the cylinder bore ring travel area. The intake and exhaust valve heads exhibited normal deposits and operating signatures. The rocker box area had an oil residue indicating lubrication to the overhead. The cylinder overhead components (valves, rocker arms, guides, springs, retainers and shafts) were lubricated and undamaged.



Cylinder #3 Part Number: 655479A11 Head Date: 3/07 Barrel Surface: Steel

Serial #: AC07BA994 Work Order Numbers: None

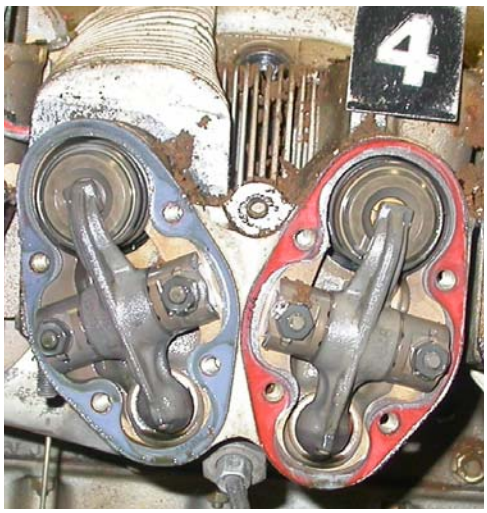
Condition: The spot putty was not evident on the cylinder hold-down nuts. The cylinder combustion chamber had a normal amount of combustion deposits and the bore condition was free of scoring and undamaged. The cylinder skirt was intact and undamaged and there were no hone marks visible in the cylinder bore ring travel area. The intake and exhaust valve heads exhibited normal deposits and operating signatures. The rocker box area had an oil residue indicating lubrication to the overhead. The cylinder overhead components (valves, rocker arms, guides, springs, retainers and shafts) were lubricated and undamaged.



Cylinder #4 Part Number: 655479A11 Head Date: 3/07 Barrel Surface: Steel

Serial #: AC07BA987 Work Order Numbers: None

Condition: The spot putty was not evident on the cylinder hold-down nuts. The cylinder combustion chamber had a normal amount of combustion deposits and the bore condition was free of scoring and undamaged. The cylinder skirt was intact and undamaged and there were no hone marks visible in the cylinder bore ring travel area. The intake and exhaust valve heads exhibited normal deposits and operating signatures. The rocker box area had an oil residue indicating lubrication to the overhead. The cylinder overhead components (valves, rocker arms, guides, springs, retainers and shafts) were lubricated and undamaged.



Cylinder #5 Part Number: 655479A11 Head Date: 6/06 Barrel Surface: Steel

Serial #: AC06FB044 Work Order Numbers: None

Condition: The spot putty was not evident on the cylinder hold-down nuts. The cylinder combustion chamber had a normal amount of combustion deposits and the bore condition was free of scoring and undamaged. The cylinder skirt was intact and undamaged and there were no hone marks visible in the cylinder bore ring travel area. The intake and exhaust valve heads exhibited normal deposits and operating signatures. The rocker box area had an oil residue indicating lubrication to the overhead. The cylinder overhead components (valves, rocker arms, guides, springs, retainers and shafts) were lubricated and undamaged.

Cylinder #6 Part Number: 655479A11 Head Date: 4/07 Barrel Surface: Steel

Serial #: AC07DA342 Work Order Numbers: None

Condition: The spot putty was not evident on the cylinder hold-down nuts. The cylinder combustion chamber had a normal amount of combustion deposits and the bore condition was free of scoring and undamaged. The cylinder skirt was intact and undamaged and there were no hone marks visible in the cylinder bore ring travel area. The intake and exhaust valve heads exhibited normal deposits and operating signatures. The rocker box area had an oil residue indicating lubrication to the overhead. The cylinder overhead components (valves, rocker arms, guides, springs, retainers and shafts) were lubricated and undamaged.

#1 Piston, Rings and Pin Piston Part Number: 654859

Condition: The piston head exhibited a normal amount of combustion deposits and the piston skirt was free of scoring and damage. The piston rings were intact, free in their grooves, exhibited normal wear and operating signatures. The piston pin and plug assembly was intact and undamaged.

#2 Piston, Rings and Pin Piston Part Number: 654859

Condition: The piston head exhibited a normal amount of combustion deposits and the piston skirt was free of scoring and damage. The piston rings were intact, free in their grooves, exhibited normal wear and operating signatures. The piston pin and plug assembly was intact and undamaged.

#3 Piston, Rings and Pin Piston Part Number: 654859

Condition: The piston head exhibited a normal amount of combustion deposits and the piston skirt was free of scoring and damage. The piston rings were intact, free in their grooves, exhibited normal wear and operating signatures. The piston pin and plug assembly was intact and undamaged.

#4 Piston, Rings and Pin Piston Part Number: 654859

Condition: The piston head exhibited a normal amount of combustion deposits and the piston skirt was free of scoring and damage. The piston rings were intact, free in their grooves, exhibited normal wear and operating signatures. The piston pin and plug assembly was intact and undamaged.

#5 Piston, Rings and Pin Piston Part Number: 654859

Condition: The piston head exhibited a normal amount of combustion deposits and the piston skirt was free of scoring and damage. The piston rings were intact, free in their grooves, exhibited normal wear and operating signatures. The piston pin and plug assembly was intact and undamaged.

#6 Piston, Rings and Pin Piston Part Number: 654859

Condition: The piston head exhibited a normal amount of combustion deposits and the piston skirt was free of scoring and damage. The piston rings were intact, free in their grooves, exhibited normal wear and operating signatures. The piston pin and plug assembly was intact and undamaged.

Lifter	#1	#3	#5	#2	#4	#6
Intake	653906	653906	653906	653906	653906	653906
Exhaust	653906	653906	653906	653906	653906	653906

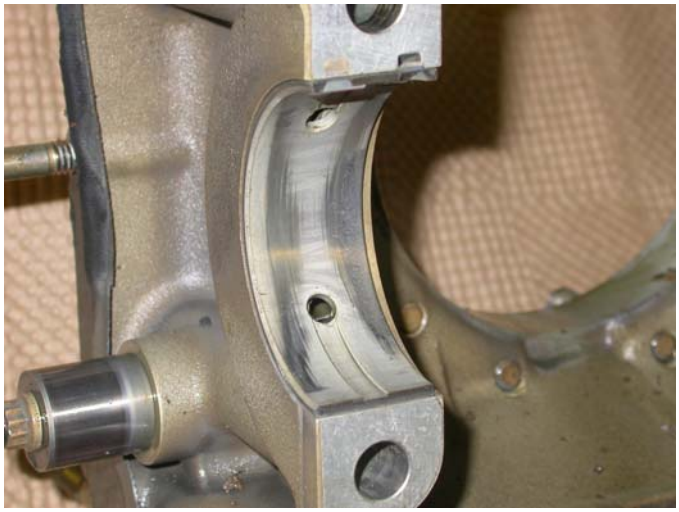
Condition: The lifter faces were undamaged and exhibited normal operating signatures. The lifter bodies were undamaged and exhibited normal operating signatures.

Crankshaft Forging number: 649877 Serial number: 890390 Heat code: RML

Condition: The crankshaft and counterweight assembly was undamaged and exhibited normal operating signatures. The connecting rod journals, main journals and thrust surfaces were undamaged and showed no signs of abnormal wear or lubrication distress. The crankshaft counterweight pins, plates and snap-rings were intact. The counterweights were undamaged and had free and unrestricted movement on the hanger blades.

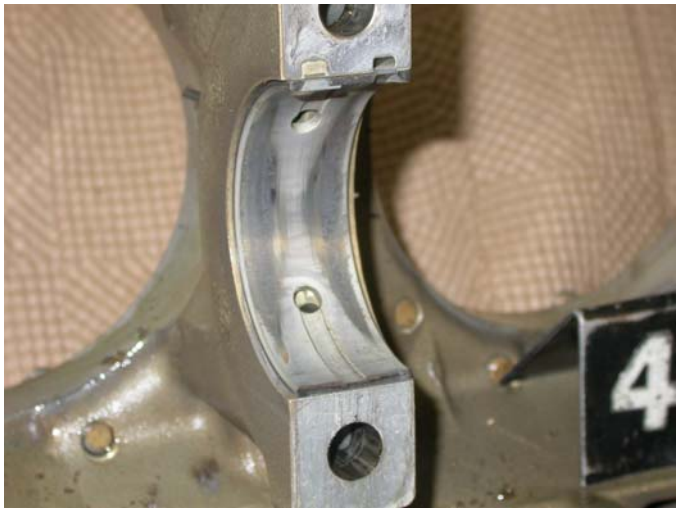
#1 Main Bearings Part #: 642337 Date Code: 2/07

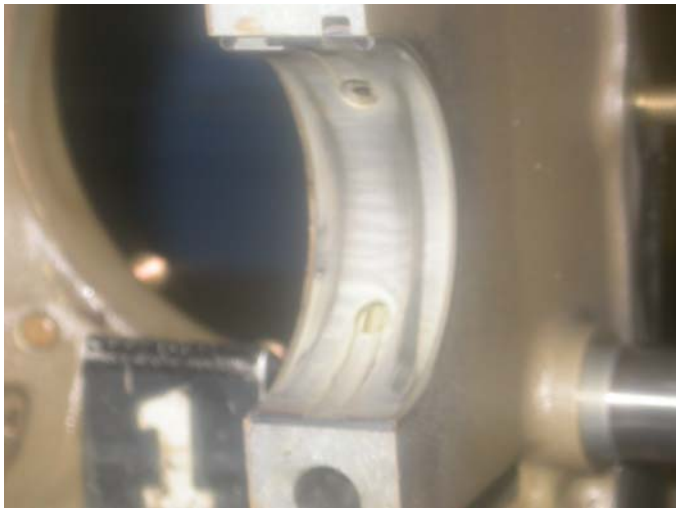
Condition The #1 (rear) crankshaft main bearings exhibited normal operating and lubrication signatures. The bearings were intact and exhibited an insignificant amount of contamination and hard particle passage. There were no signs of lubrication distress.



#2 Main Bearings Part #: 642337 Date Code: 2/07

Condition The #2 (intermediate) crankshaft main bearings exhibited normal operating and lubrication signatures. The bearings were intact and exhibited an insignificant amount of contamination and hard particle passage. There were no signs of lubrication distress.





#3 Main Bearings Part #: 642337 Date Code: 2/07

Condition The #3 (intermediate) crankshaft main bearings exhibited normal operating and lubrication signatures. The bearings were intact and exhibited an insignificant amount of contamination and hard particle passage. There were no signs of lubrication distress.

#4 Main Bearings Part #: 641992 Date Code: 8/06

Condition The #4 (front) crankshaft main bearings exhibited normal operating and lubrication signatures. The bearings were intact and exhibited an insignificant amount of contamination and hard particle passage. There were no signs of lubrication distress.

#1 Connecting Rod Part #: 654793 Forging #: 646116 Serial #: AE07DA739

Condition: The connecting rod assembly was intact and undamaged. The connecting rod nuts and bolts were intact and secure. The connecting rod bushing exhibited normal operating and lubrication signatures.

#1 Connecting Rod Bearings Part #: 642338 Date Code: 8/06

Condition: The connecting rod bearing exhibited normal operating and lubrication signatures. The connecting rod bearings were intact and exhibited an insignificant amount of contamination and hard particle passage. There were no signs of lubrication distress.

#2 Connecting Rod Part #: 554793 Forging #: 646116 Serial #: AE07DA762

Condition: The connecting rod assembly was intact and undamaged. The connecting rod nuts and bolts were intact and secure. The connecting rod bushing exhibited normal operating and lubrication signatures.

#2 Connecting Rod Bearings Part #: 642338 Date Code: 8/06

Condition: The connecting rod bearing exhibited normal operating and lubrication signatures. The connecting rod bearings were intact and exhibited an insignificant amount of contamination and hard particle passage. There were no signs of lubrication distress.

#3 Connecting Rod Part #: 654793 Forging #: 646116 Serial #: AE07DA758

Condition: The connecting rod assembly was intact and undamaged. The connecting rod nuts and bolts were intact and secure. The connecting rod bushing exhibited normal operating and lubrication signatures.

#3 Connecting Rod Bearings Part #: 642338 Date Code: 8/06

Condition: The connecting rod bearing exhibited normal operating and lubrication signatures. The connecting rod bearings were intact and exhibited an insignificant amount of contamination and hard particle passage. There were no signs of lubrication distress.

#4 Connecting Rod Part #: 654793 Forging #: 646116 Serial #: AE07DA753

Condition: The connecting rod assembly was intact and undamaged. The connecting rod nuts and bolts were intact and secure. The connecting rod bushing exhibited normal operating and lubrication signatures.

#4 Connecting Rod Bearings Part #: 642338 Date Code: 8/06

Condition: The connecting rod bearing exhibited normal operating and lubrication signatures. The connecting rod bearings were intact and exhibited an insignificant amount of contamination and hard particle passage. There were no signs of lubrication distress.

#5 Connecting Rod Part #: 654793 Forging #: 646116 SN: AE07DA761

Condition: The connecting rod assembly was intact and undamaged. The connecting rod nuts and bolts were intact and secure. The connecting rod bushing exhibited normal operating and lubrication signatures.

#5 Connecting Rod Bearings Part #: 642338 Date Code: 8/06

Condition: The connecting rod bearing exhibited normal operating and lubrication signatures. The connecting rod bearings were intact and exhibited an insignificant amount of contamination and hard particle passage. There were no signs of lubrication distress.

#6 Connecting Rod Part #: 654793 Forging #: 646116 Serial #: AE07DA760

Condition: The connecting rod assembly was intact and undamaged. The connecting rod nuts and bolts were intact and secure. The connecting rod bushing exhibited normal operating and lubrication signatures.

#6 Connecting Rod Bearings Part #: 642338 Date Code: 8/06

Condition: The connecting rod bearing exhibited normal operating and lubrication signatures. The connecting rod bearings were intact and exhibited an insignificant amount of contamination and hard particle passage. There were no signs of lubrication distress.

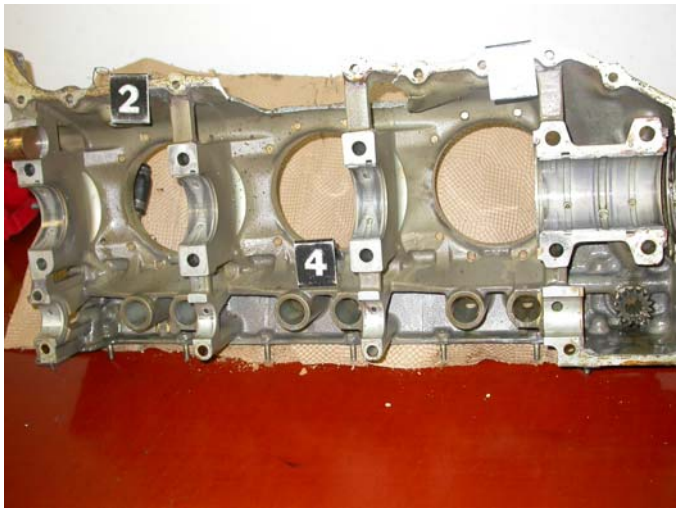
Camshaft Part number: 655531 Serial Number: Z07DA024

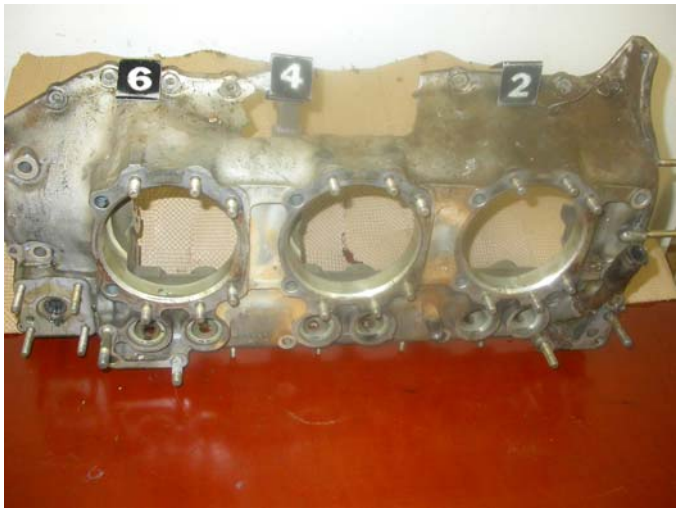
Condition: The camshaft lobes exhibited normal operating signatures. The camshaft cluster gear was intact and exhibited normal operating signatures. The gear bolts were tight and saftied and the gear teeth were undamaged.

Crankcase Casting Number 1-3-5 Side: 642333 2-4-6 Side: 642332 Serial number: S07DA118

Work Order Numbers: None

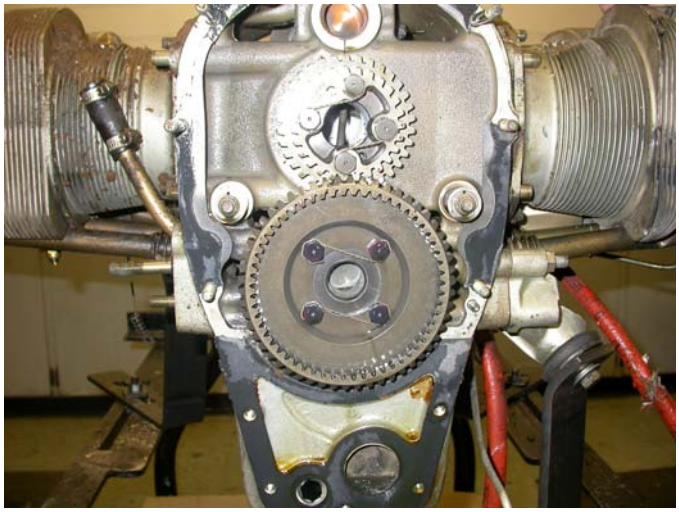
Condition: The crankcase exhibited exterior damage concentrated above the number four cylinder attachment point near the backbone. The cylinder bays were intact and undamaged. The main bearing support mating surfaces were intact and exhibited no signs of fretting or bearing tang lock-slot elongation. The main bearing support diameters were intact and exhibited no signs of bearing movement or rotation. The oil galleys and passages in the left and right crankcase halves were intact, clear and unrestricted.





Accessory Gears

Condition: The accessory gears had continuity. The teeth were undamaged and exhibited normal operating signatures.



Turbocharger

Part number: No data tag

Serial Number: No data tag

Condition: The turbocharger exhibited impact damage, but continuity was confirmed on the rotor shaft between the compressor and turbine wheels. The turbine housing was intact and there were no cracks or exhaust leaks present. The turbine blades were intact. The center housing oil inlet and outlet fittings were intact and there were no signatures of oil leakage. The center housing was intact and there were no cracks or exhaust leaks present. The compressor housing was intact and there were no cracks present. The compressor housing was attached securely to the center housing. The compressor blades were intact and they exhibited minimal erosion signatures.

Controller Part number: 633398-11 Kelly Aerospace Serial Number: KAN0093?

Condition: The controller exhibited impact damage and imbedded debris.

Wastegate Part number: 648006-8 Kelley Aerospace Serial Number: KDN00480

Condition: The wastegate (exhaust by-pass) valve was impact damaged, and the actuator was partly separated.

Propeller Governor Part number: MT Propeller D94315 Serial Number: E-8-9L #6525 SJ

Condition: The propeller governor could be rotated by hand, was intact and undamaged.

Vacuum Pump Part number: N/A Serial Number: N/A

Condition: The vacuum pump was not returned with the engine.