CIVIL AVIATION AUTHORITY
OF NEW ZEALAND

AIRCRAFT ACCIDENT REPORT

OCCURRENCE NUMBER 03/2557

CESSNA T188C AG HUSKY

ZK-MJD

KAI IWI, NEAR WANGANUI

6 SEPTEMBER 2003

Glossary of abbreviations used in this report:

AC	Advisory Circular
AD	Airworthiness Directive
ATS	air traffic services
avgas	aviation gasoline
CAA	Civil Aviation Authority
CAR	Civil Aviation Rule(s)
E	east
kg	kilogram(s)
m	metre(s)
M	magnetic
NPRM	Notice of Proposed Rule Making
NZST	New Zealand Standard Time
S	south
T	true
TBO	time between overhauls
USA	United States of America
UTC	Coordinated Universal Time
VHF	very high frequency

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OCCURRENCE No 03/2557

Aircraft type, serial number and registration:	Cessna T188C Ag Husky, T18803385T, ZK-MJD
Number and type of engines:	1 Continental TSIO-520-T(3)
Year of manufacture:	1979
Date and time:	6 September 2003, 1515 hours[1] (approx)
Location:	Kai Iwi, near Wanganui Latitude[2]: S 39° 50.5' Longitude: E 174° 55.2'
Type of flight:	Private
Persons on board:	Crew: 1
Injuries:	Crew: 1 fatal
Nature of damage:	Aircraft destroyed
Pilot-in-command's licence:	Commercial Pilot Licence (Aeroplane)
Pilot-in-command's age:	45 years
Pilot-in-command's total flying experience:	1508 hours, 60 on type
Information sources:	Civil Aviation Authority field investigation
Investigator in Charge:	Mr A J Buckingham

[1] Times are NZST (UTC + 12 hours)

[2] WGS 84 co-ordinates

Synopsis

The Civil Aviation Authority was notified of the accident about 1530 hours on Saturday 6 September 2003. The Transport Accident Investigation Commission was in turn notified shortly thereafter, but declined to investigate. A CAA site investigation was commenced next morning.

The pilot was on a local private flight, which was originally intended to consist of two or three circuits. The aeroplane was seen flying at low level in the local area, and after appearing to lose control in a turn, struck a road in a steep dive. The pilot was killed on impact and the aircraft was destroyed by impact forces and fire.

1. Factual information

1.1 History of the flight

1.1.1 About 1445 hours on 6 September 2003, the pilot flew the aeroplane off his home strip near Brunswick, his intention being to carry out a short local flight. This was a regular "off-season" event; flights were made periodically to keep the aircraft operating normally, and to avoid deterioration associated with periods of standing idle.

1.1.2 The take-off was watched by the pilot's father (an agricultural pilot himself), who commented that although the aeroplane took off in the normal distance expected for an unladen aircraft, it levelled off shortly after becoming airborne. He had expected to see the aeroplane fly two or three circuits, but it continued straight ahead and disappeared to the west.

1.1.3 In the aeroplane's absence, the father cleared some sheep from the western end of the airstrip, and some 20-30 minutes later, became concerned that his son had not yet returned. While looking towards the west for the aircraft, he saw it in the distance at low level; it appeared to be in a turn, then it disappeared from sight. A column of black smoke appeared almost immediately.

1.1.4 Several people in the Kai Iwi area, eight kilometres from the home strip, saw the aeroplane operating at low altitude, and one witness reported that it flew past her house on a southerly heading at a height that could not have been greater than about 100 feet above ground level. She reported that the engine note sounded normal. Less than a minute later, her husband called to her to telephone emergency services as he thought the aircraft was about to crash; they heard the sound of an impact immediately afterwards.

1.1.5 From the accounts of other witnesses in the vicinity, it was inferred that the aeroplane was in, or had just completed, a right turn, and appeared to "flick" into the turn, striking a line of trees and diving steeply into a large gully. State Highway 3 follows the southern side of this gully westward from Kai Iwi. A witness, located immediately south of the tree line, saw the aeroplane approaching him head-on, in the direction of some flat ground to the west of the trees, when it

appeared that control was lost. This witness and another commented that the aeroplane appeared to be flying slower than it normally would.

1.1.6 A motorist travelling east on Highway 3 saw the aeroplane hit the road immediately in front of his car and break through the crash barrier on the left side of the road. A fireball erupted on impact; the motorist was unable to avoid driving through it, but was unharmed.

1.1.7 The accident occurred in daylight, on Highway 3, one kilometre north-west of Kai Iwi (near Wanganui) at an elevation of 300 feet. Latitude: S 39° 50.5', longitude: E 174° 55.2'; grid reference: 260-R22-742499.

1.2 Injuries to persons

Injuries	*Crew*	*Passengers*	*Other*
Fatal	1	0	0
Serious	0	0	0
Minor/None	0	0	

1.3 Damage to aircraft

1.3.1 The aircraft was destroyed.

1.4 Other damage

1.4.1 Some shallow gouging was inflicted on the road surface, an 11.5-metre section of crash barrier was destroyed, and 17.5 m of immediately adjacent deer fence was flattened by the impact of the aircraft.

1.5 Personnel information

1.5.1 The male pilot, aged 45, held a Commercial Pilot Licence (Aeroplane) endorsed with Flight Radio Telephone Operator, Chemical, and C category Instructor ratings. He held a Class 1 Medical Certificate, with no limiting endorsements, valid to 28 September 2003.

1.5.2 Up to the day of the accident, he had flown a total of 1508.4 hours, including 60.4 hours on the Cessna 188, and most of the remainder on the Cessna 185 type.

1.5.3 His pilot logbook was endorsed with a Grade 2 Agricultural Rating and he had flown 714.8 hours in that role. His latest biennial flight review and Part 137 competency check were completed on 9 December 2002.

1.5.4 Before the flight, the pilot's father observed that he appeared to be his normal self and in good spirits, and that the flight was but one of several tasks to be completed that afternoon. The pilot was reputedly not one for indulging in needless low flying or exhibitionism.

1.6 Aircraft information

1.6.1 Cessna T188C, serial number T18803385T, was manufactured in 1979, and operated in the USA for the greater part of its life. It was imported into New Zealand in early 2002, with a total of 4808 hours in service, and with 1670 hours on the engine. After reassembly and inspection by a maintenance organisation, it was registered ZK-MJD on 1 July 2002, and issued with a non-terminating Airworthiness Certificate in the restricted category on 11 July 2002.

1.6.2 Up to the beginning of the accident flight, total time in service was 4920.4 hours. The most recent maintenance was a 100-hourly check on 21 August 2003, at which time several repetitive ADs were complied with, new fuel cells were fitted and the elevator trim cable replaced. An annual review of airworthiness was completed in conjunction with the 100-hourly check.

1.6.3 Continental TSIO-520-T(3) engine, serial number 239413-R, had run 1781.7 hours since overhaul. The manufacturer's recommended time between overhauls[3] is 1200 hours (if the engine is being used on aerial spraying operations), or 12 years, whichever occurs first. According to an entry in the engine logbook, the engine was being maintained in accordance with CAR Part 43, Appendix C. It was also evident, from the engine's time in service, that it was being maintained "on condition" (see 1.18) although there was no specific indication of this in the engine logbook.

1.6.4 The operator, aware of the high time on the engine, had sought advice on having it overhauled, but at the time of the accident, had not been able to progress the matter further.

1.6.5 The three-bladed, constant-speed McCauley D3A34C402/90DFA-10 propeller had run 111.8 hours since overhaul.

1.6.6 Fuel used was 100/130 avgas, the tanks having been filled before departure from the maintenance base at the time of the last check, and topped up again from a tank-trailer installation at the home strip.

1.7 Meteorological information

1.7.1 The weather was reported by witnesses as being generally fine and clear with a westerly wind. At 1500 hours the Wanganui airport automatic weather station recorded a wind velocity of 280° T/17 knots, with only a one-knot variation from this value for the hourly reports either side of this time.

1.8 Aids to navigation

1.8.1 Not applicable.

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[3] Teledyne Continental Service Information Letter SIL98-9 refers

1.9 Communications

1.9.1 Although the aeroplane was equipped with an aeronautical VHF transceiver, there were no reports of any transmissions from the pilot on any ATS or local frequencies.

1.10 Aerodrome information

1.10.1 Although not strictly "aerodrome information" as such, it is relevant to mention here that the terrain to the west of the home strip and in the Kai Iwi area is very broken, with suitable forced-landing fields few and far between.

1.11 Flight recorders

1.11.1 Not applicable.

1.12 Wreckage and impact information

1.12.1 Initial impact was with the tops of a stand of young pine trees on the crest of the escarpment to the south of the highway, and the distribution patterns of tree debris on the road surface indicated a 20-degree change of direction to the left during the tree impact sequence. The aeroplane then descended at a 28-degree angle, on a track of 015° M, striking the near side shoulder of the road with the right wingtip and impacting heavily on almost the full width of the three-lane carriageway. The road heading at this point was 320° M.

1.12.2 Both wings separated from the fuselage in the road impact, releasing the contents of the fuel tanks and resulting in an immediate fireball. The aircraft narrowly missed a motorist driving downhill towards Kai Iwi; he could not avoid passing through the fireball but was unscathed.

1.12.3 The fuselage demolished a section of crash barrier and came to rest inverted on the gully slope, about five metres down from the road edge. The wings landed separately 14 and 27 m past the main wreckage.

1.12.4 The propeller made three slashes in the road surface before disintegrating and punching one blade endwise through the crash barrier. All three blades were recovered but only a small part of the hub was identified.

1.12.5 Most of the fuselage was consumed by fire (see 1.14), but pre-impact flight control integrity was established. All extremities and control surfaces were accounted for at the site. The remains of the aircraft were removed from the site to a secure location for further inspection as required.

1.13 Medical and pathological information

1.13.1 Post-mortem examination showed that the pilot died instantly of multiple injuries consistent with a high-energy impact.

1.13.2 There was no indication of any pre-existing condition that could have resulted in incapacitation or affected the pilot's ability to fly the aircraft.

1.13.3 Routine toxicological tests found nothing of significance.

1.14 Fire

1.14.1 An intense, fuel-fed fire erupted on impact, both wing fuel tanks being ruptured as the wings were torn from the fuselage. Possible ignition sources were the hot turbocharger and exhausts, and arcing from disrupted electrical wiring.

1.14.2 Apart from both wings and the empennage, the aircraft was consumed by fire, with only ferrous components remaining. Little useful information was gleaned from the main wreckage, because of the degree of destruction.

1.15 Survival aspects

1.15.1 The pilot was wearing a combined lap and shoulder harness, but the impact forces were not survivable.

1.15.2 The aeroplane was equipped with an ACK-ELT-01 emergency locator transmitter. The unit was destroyed in the post-impact fire, and even had it operated on impact, the signal would have been very short-lived. No ELT signal was reported or detected by satellite at the time.

1.16 Tests and research

1.16.1 The engine was transported to an overhaul facility where it was stripped and examined under CAA observation. Fire and impact had severely damaged the engine, and all accessories were damaged to the extent that testing was not possible.

1.16.2 Both magnetos and ignition harnesses were destroyed, and of the 12 spark plugs, eight were machine tested, three could be tested for continuity only, and one was too damaged to test. No fault was found in those tested, and the electrodes on the remainder were normal in appearance.

1.16.3 The fuel pump and associated lines were removed: the lines were found to be clear, but the pump itself was heat damaged. The fuel control unit body was partially burned away, but the integral gauze strainer was clear. The pressure line to the fuel manifold, the injector lines and four of the six injectors were clear. The remaining two injectors could not be checked because of impact damage.

1.16.4 The turbocharger and exhaust system were severely damaged and yielded no useful information. The oil pump turned freely and appeared normal. All accessory drives were normal. The oil filter showed no abnormal deposits when opened up for inspection.

1.16.5 Numbers 5 and 6 cylinders (front right and left respectively) had sustained impact damage, number 5 head being separated from the cylinder barrel. Cylinders 1 to 4, the crankshaft, counterweights, camshaft, cam followers, pushrods, rocker assemblies, pistons, rings and connecting rods appeared normal.

1.16.6 All main bearings had worn through to the copper layer, and the big end bearing shells had worn through the lead layer. Five of the six inlet valve faces were

found severely worn, outside manufacturer's limits. See figures 1 and 2 respectively.

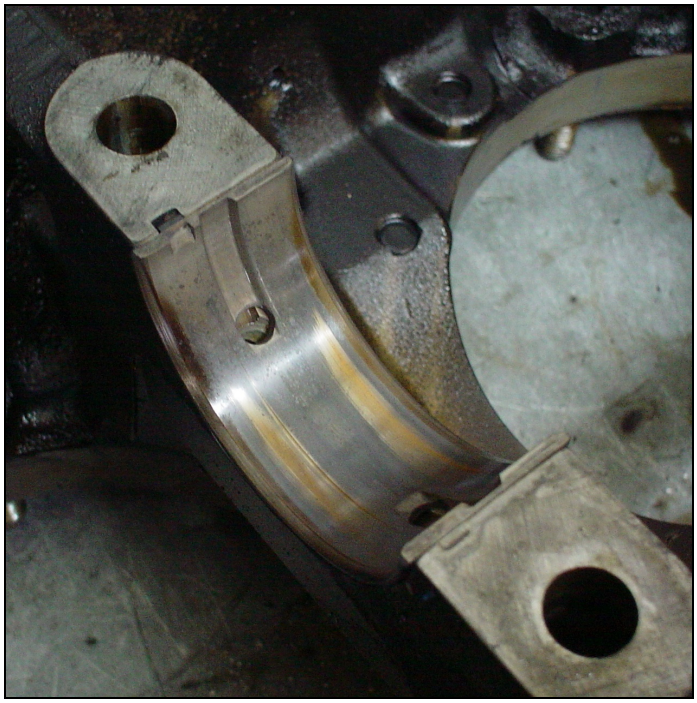

Figure 1: main bearing wear

Figure 2: number 5 inlet valve wear

(Note - there is some impact damage on outer edge)

1.16.7 Apart from the bearing wear, which was consistent with hours run, and the severe wear of the inlet valves (reportedly not uncommon on the turbocharged 520-series engines), no abnormalities were found with the engine.

1.16.8 No fuel sample was available from the engine, but a sample from the farm installation was tested after a black deposit appeared when the sample was swirled in a glass container. The contaminant was a mixture of fine sand, dust, and unidentified fibre particles, all fine enough to pass through the in-line filter used on the installation.

1.17 Organisational and management information

1.17.1 The aeroplane was owned by the farming company in which the pilot and his father were partners. The company held a Part 137 Agricultural Aircraft Operator Certificate, which permitted commercial agricultural operations. However, in the main, operations (spraying and topdressing) were confined to the properties owned by the company.

1.17.2 The position of Chief Pilot was held by a pilot from a local Part 137 operator, and maintenance was contracted out to an external provider at another aerodrome.

1.18 Additional information

1.18.1 CAR Part 43 *General maintenance rules* prescribes the requirements for the maintenance and release to service after maintenance of aircraft, and components fitted to aircraft, that are required by Part 91 to have an airworthiness certificate issued under Part 21. Appendix C of Part 43 prescribes the inspection regime for annual and 100-hourly inspection.

1.18.2 Relevant Advisory Circulars are AC 43-4 *On-condition maintenance* and AC 43-5A *Engine and propeller overhaul and testing*. Advisory Circulars contain information about standards, practices and procedures that the Authority has found to be acceptable for compliance with the associated rule.

1.18.3 AC 43-4 defines “on-condition maintenance” as a preventative process in which an item is monitored either continuously or at specified periods. The item's performance is compared to an appropriate standard in order to determine if it can continue in service. The AC also defines “airworthiness limitations” (periods, set by the manufacturer, at which specific components must be removed from service) and “hard-time maintenance” (a process where the known deterioration of an item is limited to an acceptable level by maintenance actions at given periods of time – either calendar time or hours in service in the case of a piston engine).

1.18.4 Engine manufacturers make “hard-time” recommendations, usually referred to as “time between overhaul” (TBO[4]) which specify how long they consider their products should remain in service. These are based on average utilisation and

[4]TBO is expressed in terms of hours in service; a calendar limit is usually also specified, e.g. 1200 hours or 12 years whichever is reached first

conditions and normally recommend that the engine is fully stripped and returned to the original specification. Teledyne Continental Service Information Letter SIL98-9 and Textron Lycoming Service Instruction 1009AQ are examples of manufacturers' recommendations on engine TBO.

1.18.5 AC 43-5A states that engines and propellers installed in aircraft not used for air transport operations may be maintained "on condition" rather than overhauled at fixed periods, provided that the engine or propeller meets certain conditions. In the case of propellers, however, the hours-in-service limit may not be exceeded, but if the calendar life is reached before the hours-in-service limit, then the propeller may continue in service until the recommended hours-in-service limit is reached, subject to on-condition inspection.

1.18.6 For engines, AC 43-5A states that an engine must be inspected in accordance with Part 43 Appendix C and the AC itself, at the recommended TBO (hours) and each 100 hours thereafter, and at the manufacturer's recommended calendar period (or at 10 years if none is prescribed) and each 12 months thereafter. The AC then lists sub-headings for condition inspection: *External condition; Internal condition; Oil consumption; Compression check;* and *Ground power check.*

1.18.7 Under the heading *Documentation,* AC 43-5A states: *The details of the inspections performed and the test results obtained should be entered in the appropriate log book and the release to service certified. Entries regarding the performance measurements taken should include, as applicable—*

- *idle rpm*
- *maximum rpm*
- *manifold pressure*
- *engine temperatures*
- *fuel flow*
- *ambient temperature and pressure*
- *calculated thrust or power*

1.18.8 The engine logbook for ZK-MJD contained no record of any specific "on-condition" inspection or of any baseline performance figures against which future performance could be gauged. There appears to have been a notebook carried in the aeroplane to record oil consumption, but that was not found, presumably being destroyed in the fire. Similarly, no mention was made of the inspection required at TBO, or indication as to where that might be found.

1.18.9 At present, nowhere in Part 43, or anywhere else in Civil Aviation Rules, is there any rule that specifically permits "on-condition" maintenance of engines beyond their recommended TBO. Similarly, there is no rule requiring overhaul of engines at TBO, although the requirement is implicit in the approval of an operator's maintenance programme. Approval of an (air transport) operator's maintenance

programme will be given only if the engine (and propeller) overhaul periods are in accordance with the manufacturer's recommendations.

1.18.10 The certification process in place at present permitted the issue of an Airworthiness Certificate to this aeroplane with an engine some 39% beyond TBO, without any indication of how the "on-condition" regime was to be implemented, other than an aircraft logbook loose-leaf entry certifying that "the inspections, tests and subsequent certifications have been carried out in accordance with AC 43-5A". This was not repeated in the engine logbook, which had only a reference to Part 43 Appendix C, and neither entry was accompanied by any supporting detail.

1.18.11 These, and related matters, have been of concern to CAA and the industry at large for some time. In 1997, as a result of concerns over maintenance standards and an apparent lack of CAA surveillance of maintenance on aircraft of less than 5700 kg maximum certificated takeoff weight (MCTOW), the CAA conducted an investigation into maintenance standards and practices for these aircraft. From this investigation a report was completed and a series of recommendations for further improvements developed in conjunction with industry representatives.

1.18.12 After reviews of the relevant parts of the Civil Aviation Rules, in conjunction with a Technical Study Group (TSG) comprised of industry representatives, CAA has produced a NPRM (Notice of Proposed Rule Making), which addresses, among other things, the matters raised in this section.

1.18.13 In particular, the NPRM, which was released for comment on 5 May 2005, proposes that:

- rule 43.57 *Annual and 100 hour inspections*, and Part 43 Appendix C be deleted, and the Appendix C material be retained in an Advisory Circular;
- maintenance programmes currently in accordance with Part 43 Appendix C revert to those recommended by the manufacturer (except where no such programme exists);
- AC 43-4 be cancelled as its content will be included in an updated AC 43-5;
- amendments to Part 91, Subpart G *Operator maintenance requirements* will require conformance to manufacturer's recommended TBO for piston engines used on aircraft on air transport or commercial transport operations;
- any proposed operation of engines on hire and reward (but not air transport or commercial transport) operations beyond TBO be in accordance with strictly prescribed (by rule) conditions.

1.18.14 If the proposed rule changes are accepted as per the NPRM, the areas of concern found during this investigation will be addressed, and the possibility of an engine

reaching the state of wear found in this case should be much reduced, if not completely eliminated.

1.19 Useful or effective investigation techniques

1.19.1 Nil.

2. Analysis

2.1 The investigation could not establish any conclusive reason for this accident, nor for the apparently out-of-character low-level manoeuvring that preceded it. The pilot was not given to unnecessary low flying outside the requirements of the agricultural operation, nor was he prone to gratuitous exhibitionism.

2.2 The behaviour of the aircraft after take-off suggested a substantial loss of engine power, obliging the pilot to stay at a low level, and perhaps also restricting the aircraft to a slow airspeed. With limited performance, he would have little choice in where he could fly, and most of his attention would be focussed on obstacle clearance. A second priority would be finding a safe place to land, and given the nature of the terrain in the area, this would have been a difficult task.

2.3 No pre-accident control discrepancy could be found in the aeroplane, which tends to reinforce the possibility of a power loss. However, the degree of destruction was so great that no conclusive mechanical evidence could be found to support this possibility.

2.4 The witness descriptions of the final moments of the flight indicate that the aeroplane, although it sounded normal, was flying more slowly than usual, and in or shortly after completing a right turn through about 90 degrees, it stalled and "flicked" into an incipient spin to the right. It was at this point it collided with a stand of pine trees and from there the pilot had no hope of recovery.

2.5 To the west of the trees lay some flat ground, where the pilot may have been trying to make a landing. Clearing the trees may have required a climb, to the detriment of the airspeed. Additionally, it is likely that the aircraft encountered downdraughts and turbulence just prior to the final manoeuvre, and these could have further reduced the airspeed to the point where a stall was inevitable.

2.6 Although there was no firm link established between the engine's condition and the accident, it is nonetheless disturbing to find that the engine was in poor internal condition, particularly with badly-worn main and big-end bearings, and severely worn faces on five of the six inlet valves. The latter, even if they did not contribute to the accident situation, were undoubtedly going to cause performance problems in the not-too-distant future.

2.7 This investigation also found that the current rules regime permitted an aeroplane with an engine already 39% over its recommended TBO to be issued with an Airworthiness Certificate, as well as subsequently pass an annual review of airworthiness on 20 August 2003. There was no evidence that the maintenance

organisation had conformed to the provisions of ACs 43-4 and 43-5A, particularly with respect to documenting of engine performance monitoring.

2.8 However, at the time of the accident, an extensive review of the relevant rules was already in progress, and the proposed changes, if and when adopted, should result in a more prescriptive, better-understood and safer maintenance regime for general aviation piston engines than that currently in force. Because of the existence of the review and subsequent NPRM, no further safety recommendations or actions resulted from this investigation.

3. Conclusions

3.1 The pilot was licensed, rated and fit for the flight.

3.2 The aeroplane had a valid Airworthiness Certificate and was being maintained in accordance with CAR Part 43 Appendix C.

3.3 The engine was being operated "on condition" but no useful on-condition regime or baseline performance was evident in the engine logbook.

3.4 The engine was already well over its recommended TBO when the aeroplane was imported into New Zealand.

3.5 The rules regime that permitted the operation of the engine "on condition" is currently under review, with some major improvements proposed.

3.6 Post-accident strip examination of the engine found it to be in poor condition, with worn bearings and severely worn inlet valves.

3.7 Despite the engine wear, no evidence was found to indicate a pre-accident mechanical failure or a reason for a loss of power, although the examination was severely limited by fire and impact damage.

3.8 The behaviour of the aircraft after take-off and subsequently was symptomatic of a significant power loss shortly after take-off.

3.9 Such a power loss at low level would require the pilot's full attention to obstacle avoidance and to finding a suitable landing area.

3.10 The observed loss of control was probably a stall and incipient spin resulting from low airspeed during or on completion of a turn.

3.11 The ensuing collision with the ground was not survivable.

Report written by:

(Signed)

Alister Buckingham
Safety Investigator
5 July 2005

Authorised by:

(Signed)

Richard White
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