CIVIL AVIATION AUTHORITY
OF NEW ZEALAND

AIRCRAFT ACCIDENT REPORT

OCCURRENCE NUMBER 02/3747

ZENAIR ZENITH CH-200

ZK-JLP

IN THE SEA, OFF MATAKANA ISLAND

28 DECEMBER 2002

Glossary of abbreviations used in this report:

AD	Airworthiness Directive
CAA	Civil Aviation Authority
CAR	Civil Aviation Rule(s)
E	east
ELT	emergency locator transmitter
ft	foot or feet
GPS	Global Positioning System
IAS	indicated airspeed
km	kilometre(s)
m	metre(s)
mph	(statute) miles per hour
NZDT	New Zealand Daylight Time
rpm	revolutions per minute
S	south
SAA	Sport Aircraft Association NZ (Inc)
TAIC	Transport Accident Investigation Commission
UTC	Coordinated Universal Time
VHF	very high frequency
WGS 84	World Geodetic System 1984

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Aircraft type, serial number and registration:	Zenair Zenith CH-200, 426 ZK-JLP
Number and type of engines:	1 Franklin Sport 4B
Year of manufacture:	2000
Date and time:	28 December 2002, 1055 hours[1] (approx)
Location:	In the sea, near Matakana Island Latitude[2]: S 33° 33.27' Longitude: E 176° 05.21'
Type of flight:	Private – test flight
Persons on board:	Crew: 1 Passengers: 1
Injuries:	Crew: 1 fatal Passengers: 1 fatal
Nature of damage:	Aircraft destroyed
Pilot-in-command's licence:	Private Pilot Licence (Aeroplane)
Pilot-in-command's age:	73 years
Pilot-in-command's total flying experience:	465 hours, 31.6 on type
Information sources:	Civil Aviation Authority field investigation
Investigator in Charge:	Mr T McCready

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[1] Times are NZDT (UTC + 13 hours)

[2] WGS 84 co-ordinates

Synopsis

The Civil Aviation Authority was notified of the accident at 1115 hours on Saturday 28 December 2002. The Transport Accident Investigation Commission was in turn notified shortly thereafter, but declined to investigate. A CAA investigation was commenced later the same day.

The aircraft was on a private flight from Tauranga to Waihi Beach Airfield. A number of witnesses on pleasure boats in the area saw the aircraft spin and then dive into the sea. The bodies of the two occupants were recovered almost immediately, and the aircraft wreckage next day.

1. Factual information

1.1 History of the flight

1.1.1 At approximately 1050 hours on 28 December 2002, ZK-JLP took off from its home base of Tauranga Airport for a short flight to Waihi Beach Airfield, with the 73-year-old pilot and his 18-year-old grandson on board. The pilot was also the owner and builder of the amateur-built aircraft.

1.1.2 During or just after take-off, the pilot transmitted "Oh, What happened!" Other than a later acknowledgement of joining traffic, no further radio transmissions were heard from the pilot.

1.1.3 Only a few minutes later, a number of people on pleasure boats to the north-west of the Tauranga Harbour entrance saw the aircraft flying initially straight and level, then enter a spiral dive or spin to the left. The aircraft completed 1½ to 2½ turns, appeared to recover and "flatten out" momentarily, before again pitching down abruptly and hitting the sea in a near-vertical nose-down attitude, about 80 metres from the nearest boats. The engine noise was heard to increase before the aircraft struck the water.

1.1.4 Several of the witnesses proceeded to the impact point immediately, and the bodies of the two occupants were recovered within minutes. Some small light items floated to the surface, but the main wreckage remained submerged and was buoyed by local divers.

1.1.5 Recovery of the wreckage was carried out next day, and the wreckage was transported to a secure hangar for examination.

1.1.6 The accident occurred in daylight, at approximately 1055 hours NZDT, 500 m seaward of Matakana Island, 12 km from the Tauranga Harbour entrance; latitude S 33° 33.271', longitude E 176° 05.211'.

1.2 Injuries to persons

Injuries	*Crew*	*Passengers*	*Other*
Fatal	1	1	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 Nil.

1.5 Personnel information

1.5.1 The pilot held a Private Pilot Licence (Aeroplane), but it was not current. He did not meet the requirements of Civil Aviation Rule 61.39 *Biennial Flight Review*, so was not entitled to exercise the privileges of the licence. His last biennial flight review (BFR) was performed on 12 September 2000.

1.5.2 The pilot held a test pilot approval issued in accordance with CAR Part 19 *Transition Rules*, but a condition of this approval was that his Private Pilot Licence remained current.

1.5.3 The pilot held a Class 2 Medical Certificate, valid to 20 January 2003, endorsed with a requirement for bifocal spectacles.

1.5.4 The pilot's total recorded flight time was 465 hours, with 31.6 on type. The time on type had been spread over 27 months. His flight time in the 90 days preceding the accident was about 30 minutes, which consisted of five circuits at Tauranga on 19 December 2002. These were conducted after the aircraft had been undergoing maintenance repairs to cracked engine mounts over the preceding three months. Prior to the 19 December flight, the pilot had only flown 1 hour since early May.

1.5.5 The pilot's previous flying experience before starting the CH-200 test flying programme had predominately been accumulated flying a Jodel D9 (a single seat aircraft), since about 1985.

1.5.6 The CAA database shows that the pilot was involved in one other accident. This occurred in 1990, on a cross-country flight in a Jodel D9 aircraft, when he attempted to follow a road in steep hill country in poor weather. During an attempt to turn back the aircraft stalled, was recovered, but then struck trees on rising ground. The pilot was not injured in that accident. The current CAA investigation revealed anecdotal evidence that the pilot was involved in two other non-injury accidents, but no formal record of these occurrences is documented.

1.6 Aircraft information

1.6.1 The Zenair Zenith CH-200 was an amateur-built category aeroplane which was constructed by the pilot over a 20-year period. It was powered by a 150-horsepower Franklin Sport 4 engine.

1.6.2 At the time of the accident, the aircraft had accumulated 31.6 hours of flight time. The aircraft first flew on 15 September 2000, was still in its flight-testing phase, and was operating under the terms of a special category Airworthiness Certificate which was valid to 30 June 2003, or 50 flight hours, whichever came first. Initially, an Airworthiness Certificate had been issued for 25 hours flight hours until 20 June 2001, but as the pilot had not completed all of the requirements of the flight test schedule by that time, this further certificate was issued extending the flight test period. Some of the operating limitations endorsed on the certificate included:

- Item 13 *The aircraft shall be flown solo during the flight test period;*
- Item 16 *The pilot-in-command of this aircraft shall hold a test pilot approval issued in accordance with Part 19.*

1.7 Meteorological information

1.7.1 The weather was reported as fine and clear with light winds.

1.7.2 Weather was not a factor in this accident.

1.8 Aids to navigation

1.8.1 The aircraft was fitted with a Magellan GPS. No useful information was retrieved from the unit.

1.9 Communications

1.9.1 The aircraft was fitted with a VHF radio, transponder and intercom. Apart from the routine communications with Air Traffic Control and the possibly inadvertent radio transmission just after take-off, the pilot made no calls indicating that he had any sort of problem.

1.10 Aerodrome information

1.10.1 Not applicable.

1.11 Flight recorders

1.11.1 Not applicable.

1.12 Wreckage and impact information

1.12.1 Witnesses saw the aircraft strike the sea surface in a “near-vertical” attitude. Compression crumpling of the left (pilot’s) side of the cabin, more pronounced rearward bending of the left wing spar when compared to the right wing, together with flattening of the left wing leading edge, and directional damage to all three undercarriage wheels, indicated that the left wing struck ahead of the right.

1.12.2 A witness mark made by the elevator on the rear fuselage indicated that the elevators were in the full-up position at impact.

1.12.3 Damage to the gearing in the flap operating mechanism showed that the flaps were set to half travel.

1.12.4 The throttle was in the full forward position, the mixture control was set to full rich, and it was positively established that there was fuel to the carburettor. Torsional damage to the engine frame indicated significant power at impact.

1.12.5 Pre-impact integrity of all flying control runs and surfaces was established.

1.12.6 The lockable nose wheel was found to be unlocked, and the bending and impact damage indicated that it was fully to the right when it struck the water.

1.13 Medical and pathological information

1.13.1 Post-mortem examination of the occupants concluded that death of both persons was due to multiple injuries consistent with a high-energy impact. Hand and foot injuries to the pilot were consistent with his having hands and feet on the respective controls at the time of impact.

1.13.2 There was no sign of any pre-existing medical condition that could have precluded the pilot from operating the aircraft. He was noted by friends as being remarkably fit for his age, often cycling to the airfield rather than driving.

1.13.3 Toxicological tests disclosed no evidence of alcohol, or medicinal or recreational drugs.

1.14 Fire

1.14.1 Fire did not occur.

1.15 Survival aspects

1.15.1 The accident was not survivable because of the impact forces involved.

1.15.2 Both seat belt assemblies were of the automotive diagonal click type and were found to be still secured. However, the top anchor points of both diagonal belts had failed where they anchored to the fuselage.

1.15.3 Neither occupant wore a life jacket, nor were they required to by current legislation.

1.15.4 Although the aircraft was equipped with an ACK E-01 ELT, the sudden immersion in salt water would have rendered the unit unserviceable, or, even had it operated for a short time, the signal would have been attenuated by the salt water.

1.16 Tests and research

1.16.1 Because of the damage to the nose wheel locking plate, the design history of this part was researched, and close comparisons made with the actual plate and the construction drawing requirements. This found that the plate was dimensionally correct, but the high wear rate exhibited after only 31 hours of flying (which included an estimated 110-120 landings) was due to the dimensions and shape of the nose wheel steering key, which slots into the locking plate, being incorrect.

1.16.2 The locking plate detent is semicircular in shape; therefore the nose wheel steering key should have been of a similar shape and dimension. Instead, an irregular triangular shape was found, and this had given rise to highly-loaded pressure points, which accelerated the wear rate. The location of the pivot point of the plate was also in error by about 10 mm. The key of the nose wheel assembly was set too far forward of the detent, so that most of the surface locking area of the detent was never used. The area that was used carried a large load for a small contact area, and had worn very quickly. Although the correct materials were used as specified in the construction drawings, the aircraft designer’s specifications called for a steel steering key to be matched to the locking plate made of aluminium, which is a softer material. This also promoted an accelerated wear rate, when combined with the poor fit.

1.16.3 Inspection of a set of CH-200 drawings applicable to the construction of another CH-200 aircraft, and physical comparisons with that aircraft, revealed that this wear would normally have been detectable through normal inspection techniques. However, a later factory modification that had been incorporated only in ZK-JLP consisted of two plates, being fitted one over and one under the nose wheel steering key and locking plate detent, thus concealing both the wear indication, and the poor fit and assembly. See Figure 1.

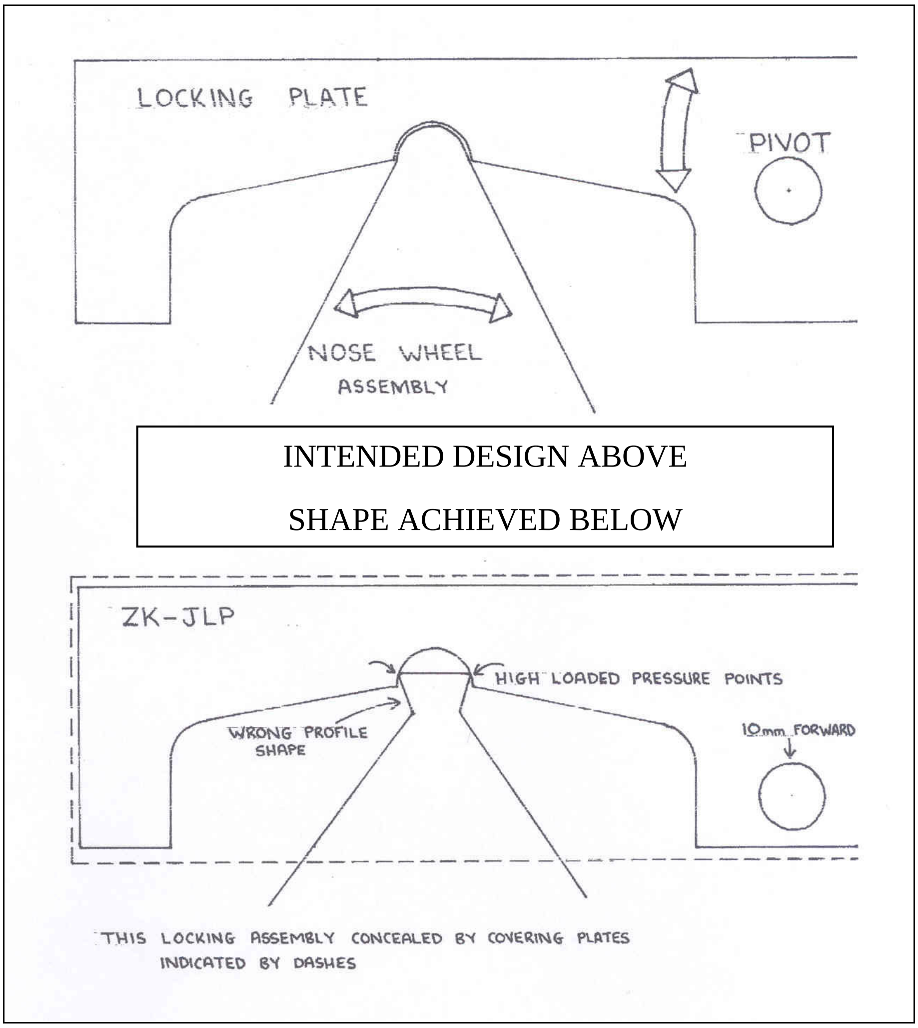

Figure 1: locking mechanism

1.16.4 The notes of the pilot's test flight programme, which comprised 16 of the 31.6 recorded hours, recorded that this aircraft stalled normally at 59 mph IAS, but the pilot had also noted:

"While investigating handling characteristics near the stall, coarse use of rudder induced spin entry. Application of rudder stopped the rotation almost immediately and recovery was normal with a height loss of 1000 ft after approximately 1½ turns."

1.16.5 The construction drawings contained the following note:

"Spin Recovery: rudder opposite, push nose down, (caution: speed will go up rapidly, stop after one or two turns and pull very slowly)."

1.17 Organisational and management information

1.17.1 Civil Aviation Rules allow the construction of amateur-built aircraft and these are usually built from either kitset or construction plan form. Once constructed, the aircraft is typically subjected to a test flight programme carried out by a nominated test pilot. Such a programme is usually of up to 50 hours duration, and the programme details tests to be carried out to determine the handling characteristics of the aircraft at various speeds and weights, in specific flying configurations.

1.17.2 Such programmes have negotiable CAA-imposed limitations attached, and these include such things as crew to be carried, and geographic areas to which operations are confined. Some of the conditions relevant to ZK-JLP are listed at 1.6.2. At the completion of a satisfactory flight test programme, test flight report and logbook statement, an Airworthiness Certificate is issued.

1.17.3 Aircraft, once constructed by the builder, are required to be inspected and released to service by a licensed aircraft maintenance engineer (LAME) who only certifies and inspects to an approved maintenance schedule, which typically details a 50 or 100 hour inspection. The aircraft builder takes responsibility for the construction of the aircraft and compliance with the designer's requirements. It should be noted that there is a significant difference between construction of a "kit aircraft" where a pre-manufactured kitset is assembled, and building an aircraft entirely from scratch from a set of plans, as in this case.

1.17.4 The CAA test pilot approval process at the time of this accident did not require that the CAA database be checked for previous accident or incident occurrences, or that the pilot's log book be checked for a valid biennial flight review prior to issue of a test pilot approval certificate. The process is an administrative assessment only, and no form of practical or theoretical competency assessment for test flying is carried out.

1.18 Additional information

1.18.1 Investigation into the handling characteristics and history of this aircraft type found that unlocking of the nose wheel steering in flight is not uncommon, and this has been documented since this accident by statements and letters from various New Zealand pilots. It is also mentioned in a TAIC accident report (89-036) concerning a previous double fatality accident with another CH-200 aircraft, but was discounted as a cause of the accident. It is noteworthy however that a CH-200 aircraft used for testing in the TAIC investigation had the nose wheel disengage in each of the three take-offs performed.

1.18.2 Experiences have also been documented in "Zenair News", the newsletter for this aircraft type, and are described variously from "uncomfortable but not dangerous" to "if it happens unexpectedly the yaw can be quite disturbing". It is significant that the yaw is much more pronounced with the nose wheel fairing fitted, as was the case with ZK-JLP.

1.18.3 In many of these cases trying to re-engage the nose wheel in flight was not attempted and the option of simply returning to land was exercised.

1.18.4 Although the unreliability of the nose wheel locking was well known in the CH-200 flying fraternity, this information and the frequency of the occurrences was not passed on to engineers or regulatory authorities, and therefore not specifically detailed in the maintenance schedules for CH-200 aircraft.

1.18.5 Once the nose wheel steering is unlocked, the accepted procedure based on the designer's notes is to climb to a safe height (eg 3000 feet), slow the aircraft down, lower flap, and yaw the aircraft about with the rudder pedals with maximum stop to stop travel, allowing the nose wheel to move from side to side and lock into the detent. Compression springs in the control run between the rudder pedals and the nose wheel made any attempt at a higher airspeed ineffective, because of the higher aerodynamic forces on the nose wheel. Any control inputs are then lost in the spring compression.

1.18.6 It should be noted that nose wheel steering can be deliberately unlocked in flight at lower than cruise airspeed. Done in a controlled manner, it is uneventful, and is often done before landing and taking off in crosswinds, when more rudder deflection is sometimes necessary. The difference is 15 degrees rudder movement when locked, versus 22 degrees unlocked.

1.18.7 Prior to 1990, stage inspections of amateur-built aircraft were conducted by CAA inspectors as part of their regulatory function, but this was discontinued as part of a major regulatory refocus resulting from the Swedavia-McGregor report. An interview with one of the inspectors of that era revealed that significant problems were often revealed in workmanship but were not unexpected, considering that many owners were first-time builders with no formal aircraft engineering training. The Sport Aircraft Association (SAA) did not continue this process, stating that their members were concerned with liability issues as inspectors.

1.18.8 Another recent investigation of a fatal accident involving an amateur-built aircraft (ZK-CSR) found that the repositioning and modification of a heater muff had allowed carbon monoxide to enter the cabin, incapacitating the pilot. Inspection of the builder's work would have been an effective defence in this case. The report is available on the CAA website, under Accidents and incidents/Fatal accident reports: occurrence 03/1675.

1.18.9 The CAA officer who issued the test pilot approval and flight test schedule was not aware that the pilot had been involved in the previous accident recorded on the CAA database or that the pilots logbook had not been endorsed with an appropriate certification for a biennial flight review. He had relied on his personal knowledge of the pilot, with whom he had been dealing only about two weeks before the accident, with regard to the engine mount repairs referred to in 1.5.4.

1.19 Useful or effective investigation techniques

1.19.1 Nil.

2. Analysis

2.1 The sequence of events, together with the indications of wear to the locking plate, suggests that the nose wheel locking did not engage, and the pilot lost control in a subsequent attempt to rectify the problem. The wear was significant and was enough to ensure that it was never going to re-engage.

2.2 The radio transmission made by the pilot shortly after take-off coincided with the point at which the lock is normally engaged in flight. Alternatively if the lock was engaged prior to take off, it is likely that it unlocked close to this same point as the aircraft speed and therefore load increased on the nose wheel and fairing. The observed manoeuvring of the aircraft several minutes later was consistent with the accepted method of re-engaging the lock.

2.3 This accepted method involved reducing engine RPM to slow the aircraft, lowering some flap, and yawing it with the rudder pedals, so that the lock would slot into place. This also placed the aircraft in a situation where a stall/spin could occur readily, and is the reason flaps are lowered to reduce stall speed. However the pilot's lack of recent flying may have been a factor. As it happened, the aeroplane appears to have stalled and entered a spin, with the rotation being arrested at too low an altitude to avoid striking the sea surface. The witness descriptions of the manoeuvring suggest that a secondary stall occurred while the pilot was trying to pull up after stopping the spin. The designer's instructions outline a need to pull very slowly. This is probably to avoid masking of the tailplane with turbulent air from the wings and thus reduce the tailplane effectiveness in controlling aircraft pitch.

2.4 Two of the closest witnesses who saw the aircraft before it entered the spin described themselves as "not being aircraft people" and not usually taking notice of aircraft overhead when they are enjoying a day's fishing. However both stated that something made them look up at it before it spun. It is consistent with the likely scenario presented in this investigation that this coincided with the RPM reduction at the start of the manoeuvre to fix the nose wheel steering. A sudden change in aircraft engine noise often attracts attention even from experienced pilots and engineers, for example, when training aircraft practise an engine failure after take-off.

2.5 The discovery during the wreckage examination of the flaps set at half travel, the flap operating mechanism also at half travel and coinciding with the flap operating gearbox teeth broken at this point, are also consistent with this scenario. It is highly unusual in any general aviation aircraft, amateur-built or certified, to be flying at cruise speed with half flap set. It is highly probable that the pilot had deliberately slowed the aircraft and lowered flap.

2.6 The nose wheel locking difficulty is a known phenomenon on this series of aircraft, and there is an accepted in-flight "fix" for the problem amongst pilots and the designer.

2.7 The pilot is likely to have experienced a similar problem six months previously when he wrote in his test flying notes that he had experienced an unintentional spin while investigating handling characteristics near the stall, when coarse use of rudder induced spin entry. This information was not passed on to the aircraft certifying engineer.

2.8 The defect and incident reporting requirements of CAR Part 12 *Accidents, Incidents, and Statistics* were not met in the previous incidents that occurred to aircraft of this type. Such a gathering and sharing of information provides a useful defence mechanism to engineers and amateur aircraft builders.

2.9 Regulatory authorities and engineers were not aware of the frequency of this recurring problem, so normal engineering defences such as amended maintenance schedules or Airworthiness Directives did not eventuate.

2.10 The pilot had been issued with a test pilot approval, however, the lack of a biennial flight review meant that his Private Pilot Licence was not current, and that he could not exercise the test pilot approval privileges. The conditions endorsed on the interim Airworthiness Certificate restricted the pilot to flying the aeroplane solo. He was not entitled to be carrying a passenger on the accident flight.

3. Conclusions

3.1 The pilot was licensed and authorised as a test pilot, but did not meet biennial flight review requirements, and therefore could not exercise the test pilot approval privileges.

3.2 The aircraft was still engaged in a test flight programme and as such was not permitted to carry passengers.

3.3 At an early stage of the flight, the nose wheel steering lock either disengaged or failed to engage.

3.4 While attempting to re-engage the steering lock, the pilot lost control at an altitude too low to permit a recovery.

3.5 The other available options of returning to land or climbing to carry out the manoeuvre at a greater altitude were not used.

3.6 The pilot had lost control on a previous occasion, at a higher altitude, and so should have been aware of the altitude required for recovery.

3.7 The resulting impact with the sea was not survivable.

3.8 The design of the nose wheel steering lock has proven to be unreliable in service, even when constructed correctly.

3.9 A construction error relating to the fit in the locking mechanism had resulted in accelerated wear and worsening of the problem.

3.10 The damage could not be seen on a daily inspection, because of the modification requiring the addition of two covering plates.

3.11 The previously-required stage inspection process probably would have discovered the problem before the cover plates were fitted.

3.12 Timely reporting of previous similar incidents on this type of aircraft could have resulted in measures that would have prevented this accident.

4. Safety actions

4.1 The CAA is considering making it a requirement that, during construction and prior to issue of an Airworthiness Certificate, the following components of all amateur-built aircraft designed to carry passengers are subject to stage inspections to confirm proper construction and function of:

(a) the aircraft control system, and

(b) any other vital point, the failure of which would lead to an accident.

4.2 The CAA has issued Airworthiness Directive DCA/ABUILT/8 for this aircraft type, to address the unsafe conditions concerning the construction, locking and operation of the nose wheel assembly. The effective date of the AD was 22 April 2004.

4.3 The CAA has amended the test pilot authorisation procedure to include a check of the CAA database for occurrences and the pilot's logbook for a current biennial flight review, before issuing a test pilot certificate.

4.4 The CAA has planned a "roadshow" presentation to general aviation pilots, to demonstrate the safety advantages to be gained in defect and incident reporting under Part 12. This will include amateur-built aircraft, and is likely to include this accident as an example.

4.5 The CAA is currently using this accident as an example for similar purposes, and to demonstrate the importance of having certain maintenance items double checked, in Maintenance Controller courses being conducted around New Zealand.

4.6 All reported aircraft defects are now published on the CAA website, where they are searchable by aircraft type. This enables owners, pilots and engineers to review information on their aircraft type and develop risk management strategies.

4.7 The CAA intends to advise the aircraft designer of the unintended consequences of his modification requiring the addition of the two covering plates, referred to in 3.10.

Report written by:

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23 August 2004

Authorised by:

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