AIRCRAFT ACCIDENT REPORT

No. 88-014

QUAD CITY ULTRALIGHT CORPORATION CHALLENGER II ZK-RJX Near Te Tipua 7 February 1988

Transport Accident Investigation Commission
Wellington New Zealand

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Transport Accident Investigation Commission
Wellington

Chief Commissioner
Transport Accident Investigation Commission

The attached report summarises the circumstances surrounding the accident involving Quad City Ultralight Aircraft Corporation Challenger II microlight ZK-RJX on 7 February 1988 near Te Tipua, 11 km west-south-west of Mataura and includes suggested findings and safety recommendations.

This report is submitted pursuant to Section 8(2) of the Transport Accident Investigation Act 1990 for the Commission to review the facts and endorse or amend the findings and recommendations as to the contributing factors and causes of the accident.

19 September 1990

R CHIPPINDALE
Acting Chief Executive

APPROVED FOR RELEASE AS A PUBLIC DOCUMENT

12 October 1990

M F DUNPHY
Chief Commissioner

AIRCRAFT:	Quad City Ultralight Aircraft Corporation Challenger II Microlight	**OPERATOR:**	Mr R.J. Cross
REGISTRATION:	ZK-RJX	**PILOT:**	Mr P.W. Cunningham
PLACE OF ACCIDENT:	Near Te Tipua, 11km west-south-west of Mataura	**OTHER CREW:**	Nil
DATE AND TIME:	7 February 1988, 1534 hours	**PASSENGERS:**	One

SYNOPSIS:

The Senior Inspector of Air Accidents based at Christchurch Airport was advised of this accident at 1639 hours on 7 February 1988. Mr D.G. Graham was appointed Investigator in Charge and commenced the field investigation the following day. The aircraft was returning to Gore Aerodrome from a private airstrip. A local farmer observed the aircraft pass over this property about 400 feet above ground level, in normal cruising flight. Shortly afterwards it rolled to the left and entered a steep dive from which it was not recovered. The two occupants received fatal injuries in the ensuing ground impact.

1.1 HISTORY OF THE FLIGHT:
See page 4

1.2 INJURIES TO PERSONS:
Pilot: 1 Fatal
Pax: 1 Fatal

1.3 DAMAGE TO AIRCRAFT:
The aircraft was destoryed by impact forces.

1.4 OTHER DAMAGE:
Gouging of the grass surface and minor damage to the post and wire boundary fence.

1.5 PERSONNEL INFORMATION:
See page 5

Flight Times

	Last 90 days	Total
All Types	16	1368
On Type	N/K	At least 4 hrs 30 mins

1.6 AIRCRAFT INFORMATION:
See page 7

1.7 METEROLOGICAL INFORMATION:
See page 8

1.8 AIDS TO NAVIGATION:
N/A

1.9 COMMUNICATION:
See page 9

1.10 AERODROME:
N/A

1.11 FLIGHT RECORDERS:
N/A

1.12 WRECKAGE AND IMPACT INFORMATION:
See page 9

1.13 MEDICAL AND PATHOLOGICAL INFORMATION:
See page 11

1.14 FIRE:
Fire did not occur

1.15 SURVIVAL ASPECTS:
The occupants were each wearing lap belt and a motorcycle type safety helmet. Ground impact forces were of such severity that the accident was unsurvivable. ZK-RJX was not fitted with an emergency parachute system.

1.16 TESTS AND RESEARCH:
See page 12

1.17 ADDITIONAL INFORMATION:
See page 15

1.18 USEFUL OR EFFECTIVE INVESTIGATION TECHNIQUES:
N/A

2. ANALYSIS:
See page 15

3. CONCLUSIONS:
See page 18

4. SAFETY RECOMMENDATIONS:
See page 19

* All times in this report are NZDT

1. FACTUAL INFORMATION

1.1 History of the flight

1.1.1 On the day of the accident local microlight owners had intended holding a "fly in" and barbecue at a private airstrip near Te Tipua about 20 km south-west of Gore Aerodrome but these arrangements were later changed. The owner/builder of Challenger II microlight ZK-RJX had however decided to fly to the airstrip in the early afternoon with a farming friend who was also an instructor pilot at the Southern Districts Aero Club based at Gore Aerodrome. The two men had been joined by the property owner who was also a microlight owner and pilot, and later by several others who had travelled to the airstrip by road.

1.1.2 Another aircraft "Midget Mustang" ZK-EDP arrived at the airstrip shortly after ZK-RJX. This aircraft was flown by a friend of the two men, an experienced pilot, who had also previously owned and operated microlight aircraft. Some time was spent by those at the airstrip (including the visiting pilot of ZK-EDP), in an inspection of ZK-RJX as the Challenger II was the sole example of its type in the area. During this inspection it was noted that the rear support strut for the right horizontal tailplane was severely dented. Some discussion ensued concerning this damage and the owner explained that it had occurred when the aircraft, which was stored in a barn on his property, had been affected by gusty winds a few days earlier, dislodging the tail from a drum on which it had been resting.

1.1.3 The owner and the instructor pilot were both aware that the damage would have resulted in a loss of strength in the strut, particularly in compression, but in general consensus it was considered that the aircraft's airworthiness was not compromised. The owner indicated that a replacement strut would be obtained and fitted at the earliest opportunity.

1.1.4 Following this inspection which revealed no other evident defects, at the invitation of the owner, the pilot of ZK-EDP took ZK-RJX for a ten minute local flight. He reported that the aircraft performed satisfactorily in the prevailing slightly "lumpy" conditions and handled much as expected. He found no difficulty in controlling it (in all three axes) and observed nothing to surprise him or cause concern regarding the particular characteristics of ZK-RJX as a microlight aircraft.

1.1.5 After this flight it was arranged that the instructor pilot would fly ZK-RJX on another short local flight, carrying as a passenger one of the visitors to the airstrip, who was an experienced hang glider pilot. The purpose of this flight was to enable a video recording to be made of the Midget Mustang in flight, the latter aircraft being filmed by the passenger from the rear seat of ZK-RJX. The flight, which lasted some 15 minutes, was completed without incident and both aircraft returned to the airstrip.

1.1.6 ZK-EDP then departed for Gore Aerodrome. The owner and the instructor pilot boarded ZK-RJX a short while later, also intending to fly to Gore Aerodrome. The instructor pilot occupied the front seat. Both

occupants appeared to be in good spirits, with no indication of physical disability in either case. The take-off and departure to the north-east was recorded on video. After becoming airborne the pilot carried out a moderately steep turn to the left and flew at a low height over the airstrip before climbing to an estimated height of some 300 feet above ground level and departing on track towards Gore Aerodrome. The video recording provided no evidence to suggest that the performance or controllability of ZK-RJX during take-off and departure was affected or degraded in any way.

1.1.7 A local farmer had observed ZK-RJX proceeding to the private airstrip earlier in the afternoon and had identified it as a microlight by the characteristic noise from the two stroke engine. Hearing the aircraft approach his property again on the return flight, he followed its progress using a pair of field glasses. The aircraft appeared to be flying quite normally as it passed slightly east of his home at an estimated height of some 400 feet agl. As the farmer continued to watch the aircraft which was in level flight, it "tilted to the left" to an angle in excess of 30° and then descended towards the ground. The descent angle was so steep that the farmer realised an accident was inevitable.

1.1.8 There was no signficant variation in engine sound during the aircraft's cruising flight and subsequent descent. The farmer stated that the engine was running normally throughout his observation of the flight, although he considered it might have been shut down immediately before ground impact. He reported that the aircraft was flying sufficiently high to have enabled the pilot to glide to suitable flat land (above the elevation of the accident site) had an engine malfunction or stoppage occurred in flight. In the event, however, the steep, apparently uncontrolled descent, resulted in the aircraft impacting the undulating pastureland intersected by gullies, over which it was flying at the time.

1.1.9 The farmer and his wife proceeded without delay to the scene of the accident but were unable to render assistance. Both occupants had received fatal injuries on impact. The accident occurred at 1534 hours NZDT. The accident site was in a paddock beside Roughan Road, near Te Tipua, 11 km west-south-west of Mataura, at an elevation of 400 feet amsl. National Grid Reference 802351 (NZMS 260 Sheet F46 "Mataura") Latitude 48°12'14"S, longitude 168°42'30"E.

1.5 Personnel information

1.5.1 The pilot in command, Peter William Cunningham, 34, who occupied the front seat of ZK-RJX, had commenced his flying training in December 1975. He obtained a Private Pilot Licence in December 1976 and in November 1980 was issued with Commercial Pilot Licence (Aeroplane) number 3998. The Validity Certificate associated with this licence was valid from 22 December 1987 to 7 December 1988.

1.5.2 In December 1982, Mr Cunningham was issued with a "C" Category Instructor Rating. This Rating was upgraded to a "B" Category Instructor Rating in October 1986. The last annual renewal check for his Instructor Rating was carried out on 4 December 1986.

1.5.3 The last recorded entry in Mr Cunningham's Pilot's Logbook was dated 31 November 1986. However the flying sheets of the Southern Districts Aero Club where he had continued to instruct on a regular basis provided details of his flying up to the day of the accident. As at 6 February 1988 Mr Cunningham had accumulated a recorded total of 1368 hours and 15 minutes flying. This was comprised of 114 hours Dual and 1249 hours 45 minutes Pilot in Command by day, and 4 hours 30 minutes night flying. 723 hours and 40 minutes of this total was Instructional Flight Time.

1.5.4 Mr Cunningham held a Type Rating Certificate for aircraft in Group B, C, F and G and had flown a variety of single engine light aircraft, including the "Midget Mustang" of which he was part-owner. He had not recorded in his Pilot's Logbook any time flown on microlight aircraft.

1.5.5 A notebook was maintained by Mr R.J. Cross, the owner of Challenger II microlight ZK-RJX in which he had recorded the aircraft's flying hours and the initials of the pilot on each flight. Mr Cunningham was indicated as the pilot of ZK-RJX on 11 November 1986 and had subsequently made a further four flights, accumulating 4 hours and 15 minutes recorded flight time in ZK-RJX up to 19 April 1987 when entries in the notebook ceased.

1.5.6 Within the 90 days preceding the accident Mr Cunningham had flown a recorded total of 16 hours 15 minutes on instructional flying at the local aero club. In the absence of any entries in his Pilots Logbook to cover flights made by him in microlight aircraft over the nine month period since April 1987, neither his total flight time on ZK-RJX, nor his flight time within the last 90 days, on this aircraft, could be established. However, he had flown ZK-RJX with a passenger on a flight of some 15 minutes duration immediately prior to the accident flight and the available evidence indicated that he was in current practice on this particular microlight type.

1.5.7 The occupant of the rear seat, Mr Roger John Cross, 35, was the holder of Advanced Pilot Certificate number 495/3 (Group Rating B, 3 axis control), issued by the Microlight Aircraft Association of New Zealand (MAANZ). This certificate was valid from 22 March 1987 to 21 March 1989.

1.5.8 Mr Cross was also the holder of Student Pilot Licence (Aeroplane) number 80594 issued in June 1984. This licence had been renewed in 1986 and was valid until November 1988. He had initially undertaken flying training during 1972 and 1973 but had recommenced this training in 1984 and by February 1986 had accumulated a total of 27 hours dual and 34 hours pilot in command on light aircraft. He had subsequently recorded 64 hours flying as pilot in command on the Challenger II Microlight ZK-RJX, the last entry in his Pilot's Logbook being dated 19 April 1987.

1.5.9 No records were available to determine precisely the extent of further flying by Mr Cross in ZK-RJX, but he had flown the aircraft

frequently during recent weeks prior to the accident. Mr Cross was in the habit of inspecting his aircraft regularly and maintaining it in a clean and serviceable condition. On the morning of the accident he had spent some time in washing ZK-RJX and carrying out a detailed inspection before departing from his property for Gore Aerodrome.

1.6 Aircraft information

1.6.1 Quad City Ultralight Aircraft Corporation Challenger II microlight aircraft, serial number 375, ZK-RJX was imported as a kitset and assembled by Mr Cross the owner, during 1986.

1.6.2 The aircraft was surveyed by a Licensed Aircraft Maintenance Engineer, authorised by the Civil Aviation Division for the purpose, and a Permit to Fly was issued on 10 November 1986 which remained valid until 9 November 1987. At the time of the accident, the Permit to Fly had not been renewed.

1.6.3 ZK-RJX was fitted with a Bombardier-Rotax 447 engine, driving a 2 bladed wooden propeller of 52 inch (1320 mm) diameter x 34 inch (864 mm) pitch.

1.6.4 The maximum authorised mass of the aircraft was 358 kg. The centre of gravity limits were not specified but the front seat pilot's mass was required to be between 57 kg and 114 kg. There was no ballast installed in the nose of the aircraft.

1.6.5 The estimated mass of the aircraft at the time of the accident was 350 kg. The front seat pilot's mass was 83 kg.

1.6.6 The fuel tank installed in ZK-RJX was of welded aluminium construction with a capacity of approximately 60 litres. Mr Cross had fitted a fuel tank of large capacity to facilitate extended cross-country flights in his aircraft. The quantity of fuel on board ZK-RJX at the time of the accident could not be established but was estimated to have been in excess of 20 litres.

1.6.7 The owner had incorporated a number of modifications in ZK-RJX. These included the installation of additional longitudinal structure on both sides of the fuselage raising the height of the cockpit sides and enabling the throttle quadrants on the left of the cockpit to be positioned at a higher level. Other modifications included:

Trimming of rear rudder pedals to avoid interference with front seat occupant,

Sheet metal flooring in the rear cockpit area,

Lock-nuts on aileron push-rods,

Drilled and pinned control cable pulleys,

Fabric tape leading edge protection - wingtips/tail section,

Lock-nuts on stub axle wheel retainer bolts,

Aluminium plates and clip installation to reinforce the velcro junction in wing covering,

Installation of large capacity aluminium fuel tank,

Elevator "spring-bias" installation,

Installation of a lightweight VHF transceiver and power supply.

1.6.8 ZK-RJX was fitted with flying controls for normal operation of the aircraft from the front seat. A centrally mounted tubular control column provided pitch control through a fuselage push rod and bell crank assembly operating individual push rods connected to each elevator and roll control through a system of cables, bell cranks and short push rods attached to each aileron. The rudder was controlled by cables connected to the front seat rudder pedals.

1.6.9 The elevator and aileron control system was connected to a "dual" installation, incorporating a stub control tube assembly, to enable the aircraft to be flown from the rear seat. At the time of the accident no control column for the rear seat occupant was installed. The rear rudder pedals were fitted but were not connected to the front pedals or the rudder. A throttle control positioned on the left rear side of the cockpit was interconnected with the pilot's throttle control and could be used by the rear seat occupant to control engine power.

1.6.10 A light tension spring had been attached between the forward lower section of the front control column and the nose wheel mounting tube, evidently to provide a "nose-up" bias. The extent of nose-up trim exerted by this spring and its effect, if any, on the stick-free pitch stability of ZK-RJX in cruising flight with the two persons on board immediately before the accident was not established.

1.7 Meteorological information

1.7.1 During the afternoon of 7 February 1988 pressures were low to the north of North Island and a ridge lay over South Island. A small depression was located over Central Otago. This was largely of heat low origin but also was associated with the remnants of a trough situated over Northland.

1.7.2 The weather at Invercargill (36 km south-west of the accident site) at 1500 hours, was reported as isolated cumulus at 1000 feet, good visibility, with a sea breeze, south-south-west at 10 knots. Temperature was 21°C. The QNH was 1015 Hpa. At Lumsden (57 km north-west of the accident site) the wind was south-east at 15 knots and the temperature was 28°C.

1.7.3 The pilot who had flown ZK-RJX earlier and who had flown Midget Mustang ZK-EDP from the airstrip to Gore Aerodrome shortly before the accident, reported that it was a pleasant, warm clear and sunny afternoon. The wind was light and variable. There was some mild thermal instability but he had experienced no difficulty in handling the microlight

aircraft in these conditions. At the airstrip prior to his departure in ZK-EDP he noted that the wind was mainly easterly, freshening to 8 to 10 knots at times. No significant turbulence was experienced during his flight to Gore, at a height of 2000 feet. Lighter southerly conditions prevailed at Gore Aerodrome when he landed.

1.7.4 The hang glider pilot who had flown in ZK-RJX as a passenger early in the afternoon, stated that during the flight the wind was variable at about 6 knots. Some "fairly lumpy thermals" were encountered. At the time that ZK-RJX departed for Gore Aerodrome, he observed that the wind had "picked up" to an estimated 12 knots from a south to south-westerly direction as the sea breeze penetrated inland.

1.7.5 The Director of the New Zealand Meteorological Service in a report on the prevailing weather conditions commented:

"At the crash site it is likely there was little or no cloud. Factors affecting aircraft handling could have been:

(i) thermal turbulence - indicated by the high temperatures inland, and/or

(ii) wind shear - it is possible that there was a convergence zone in the area between the sea breeze from the south coast and the north-easterly from the east coast. There is no way, from the information available to say where this convergence lay, if indeed it did exist.

There is also the possibility that the combination of high temperatures and some local convergence in the wind flow could have produced a 'willy willy' or 'dust devil' type of thermal with consequent difficult handling problems."

1.9 Communications

1.9.1 The owner/builder of ZK-RJX had incorporated the necessary wiring, mountings and aerial for the carriage and operation of a lightweight portable very high frequency (VHF) transceiver and its dry-cell power supply in the aircraft. At the time of the accident however, no transceiver unit, nor intercommunication system (to facilitate conversation between the occupants) was installed.

1.12 Wreckage and impact information

1.12.1 The wreckage of ZK-RJX lay against the post and wire fence bordering a paddock in rolling hill country 2.7 km north-east of the airstrip from which the aircraft had earlier taken off. The wreckage trail was on a heading of 017°M. The paddock which was markedly undulating, had a transverse downslope of some 10° at the accident site and the aircraft had initially impacted the grass surface some 50 m beyond a gully which traversed the paddock to the west.

1.12.2 A series of gouge marks indicated that the left wingtip had struck the ground first, 26 m from the fenceline, with the aircraft in a

steep nose down attitude, while banked to the left. The nose struck the grass surface heavily, resulting in the tubular structure on the left side fracturing on impact, with some members becoming embedded to a depth in excess of 400 mm. The evidence indicated that the nose-down angle of impact was approximately 50°.

1.12.3 Major disruption to the forward section of the fuselage, comprising the complete cockpit area, occurred on impact and various items from the aircraft and structural components were distributed over an area about 21 m long by 10 m wide. The aircraft's ground slide was arrested when it struck the fence. Severe staining of the grass over a wide expanse indicated that there was a significant quantity of fuel in the aircraft's aluminium fuel tank, which had ruptured on initial ground impact.

1.12.4 All components of the aircraft were accounted for at the site. The wing attachments, including supporting struts and rigging showed damage consistent with the mode of impact and the severe forces involved. The instrument panel, mounted forward of the front seat was completely destroyed in the accident. No information was available from the aircraft instruments.

1.12.5 The rear mounted engine and pusher propeller assembly had completely separated from its six individual mounts in a forward and downward direction as a result of the severity of initial impact. One propeller blade had shattered but the broken pieces were recovered in the wreckage. The throttle control to the engine had broken due to impact forces. The throttle slide within the carburettor was in the "CLOSED" position. A quantity of residual fuel mixture remained in the carburettor bowl. The choke was in the "OFF" position, the internal filter within the carburettor was clear and the engine air intake was clear. There was no indication that any malfunction or failure of the engine or propeller assembly, or its mounting installation had contributed to any in-flight emergency or loss of control.

1.12.6 The integrity of the control circuits for aileron, rudder and elevator was established. The pilot's control column was bent and distorted in a manner consistent with the severity of the nose-down impact. The damage sustained provided no conclusive evidence as to whether or not the control column was being held by the pilot at the time of the impact.

1.12.7 The left tailplane was intact and the left front strut, which, together with the rear strut, supported the tailplane in a horizontal plane relative to the fin and rudder assembly, was straight and its external surface undamaged. However the left rear strut was slightly bent at a location (17 mm from the lower attachment) where it had been weakened due to visible external damage evidently sustained prior to the accident flight.

1.12.8 In contrast, the right tailplane had collapsed downwards (at some stage during the accident sequence) and lay at an angle about 70° below the horizontal. The right rear support strut had fractured completely

at a point where it had clearly been severely dented externally some time before the accident occurred. The front strut had folded through approximately 80° at its mid point, with significant deformation of the brackets which attached it to the tailplane and fuselage. There was no evidence of prior damage to the external surface of the front strut.

1.12.9 It was noted during examination of the tailplane that four of the brackets attaching the support struts to the tailplane spars and rear fuselage tubular structure were cracked along the line of the "pop" rivets holding the folded brackets to the structure. However the brackets had not failed. It was evident that these brackets were prone to cracking in normal service.

1.13 Medical and pathological information

1.13.1 Mr Cunningham had undertaken a medical examination for the renewal of his Commercial Pilot's Licence - Aeroplane on 1 December 1987 and had been assessed fit.

1.13.2 His initial medical examination (for the issue of a Student Pilot Licence) had been carried out in November 1975. Since that time Mr Cunningham had undergone routine medical examinations, at regular intervals, to maintain the continuity of his pilot licence. He had been assessed "fit" to Commercial Pilot Licence standards on each occasion that he had renewed his licence since December 1976. The required medical assessments had been conducted by various medical practitioners.

1.13.3 Pathological examination following the accident determined that Mr Cunningham was suffering from chronic sarcoidosis. This condition was first diagnosed at autopsy. There was no evidence that Mr Cunningham was aware of his illness, or of any symptoms prior to the accident. He had however, suffered from fatigue and as a result had relinquished some sporting activities.

1.13.4 The Senior Lecturer in Aviation Medicine at Otago University reported upon the medical findings as follows:

> "Sarcoidosis is an unusual condition characterised by granuloma formation with associated immunological changes. The disease may be acute with an abrupt onset, and usually resolving over a period of months or years, or chronic, with an insidious onset and an unfavourable prognosis if untreated. Sarcoidosis most commonly affects the lung, but may be found in other organs, such as liver and heart as it was in this case. Microscopic evidence of sarcoid granulomas in the heart carries a significant risk of sudden death and this may precede any other symptom of chronic, disseminated sarcoidosis. There was moderately high probability that the myocardial involvement, with focal inflammation, would have caused incapacitating symptoms such as collapse or premature sudden death within a period of years. The circumstances of this accident would suggest that pilot incapacitation may have been the primary cause of the accident and the medical findings would indicate that this was a significant probability. It is impossible to 'prove' by

pathological examination, that symptoms or sudden death prior to impact, occurred, but there are a number of corroboratory features to support this conclusion, namely:

There was no evidence of survival after impact,

There were no injuries to the hands that would suggest that the control column was being held, or hands used to brace, at the impact of impact,

The aircraft's departure from normal flight was consistent with the control column being released from the grip of the possibly incapacitated pilot, and slumping of the body may have caused greater pressure on one foot on the rudder pedal."

1.13.5 The Senior Lecturer in Aviation Medicine commented further:

"Assuming that the pilot did collapse or die, due to cardiac arrest, he could be expected to slump rather than go into any spasm. The aircraft was initially flying straight and level, then adopted a steep nose down altitude and a 30° bank. There is a rearwards tilt on the seat backs, and illustrations show the pilots leaning forward slightly out of their seats when flying the aircraft. A sudden flaccid collapse would suggest that the pilot would slump backwards, perhaps falling sideways as he collapsed back into his seat. If the aircraft were to lose speed or pitch down, the pilot might subsequently slip forward onto the control column. Any recovery using the rear cockpit control stub would have been impossible due to the lack of leverage. The displacement and distortion of the forward control column on impact would be expected as the aircraft cockpit was compressed."

1.16 Tests and research

1.16.1 The tail section of ZK-RJX was assembled with the rear support strut for the right horizontal stabiliser detached, to assess the effect of a complete failure of the latter strut on the ability of the right tailplane to sustain static loading when supported solely by its forward strut. The right tailplane in this configuration supported a static load of 40 kgs, evenly distributed chordwise, positioned at tailplane mid-span, without permanent deformation or evidence of distress in the front strut.

1.16.2 The failed front and rear support struts from the right horizontal stabiliser were submitted to the Southern Industrial Development Division/Department of Scientific and Industrial Research (SIDD/DSIR) for detailed metallurgical examination. The Director of the SIDD/DSIR reported as follows:

"HORIZONTAL STABILISER

The right side horizontal stabiliser front and rear tubular support struts had broken, the two parts of which were still attached to their support brackets on the stabiliser frame. The front stabiliser frame support strut

bracket, exhibited evidence of severe distortion in a 45° forward direction. The rear stabiliser frame support strut bracket was not significantly distorted. ...

RIGHT SIDE - FRONT STABILISER SUPPORT STRUT

The front stabiliser support strut had fractured as a result of folding approximately 24.5 cm from the horizontal stabiliser bracket, with the fracture consisting of generally fine fibrous features indicative of ductile overload as the mode of failure, with evidence of areas of abrasion damage to the fracture surface due to folding generally confined to near the outside diameter surfaces on the inside of the tube fold. The tube had folded approximately 80° before breaking.

RIGHT SIDE - REAR STABILISER SUPPORT STRUT

The rear stabiliser support strut had fractured approximately 12.5 cm from the horizontal stabiliser bracket. Fitting together the fracture surfaces showed that the tube had folded about 80° prior to failure. The fracture surfaces exhibited generally fine fibrous features indicative of ductile overload as the mode of failure. One side of the fracture (the shorter of the two pieces) showed a shallow indented band, containing brownish coloured deposits (subsequently found to be iron rich, probably rust) on the underside surface of the strut, running adjacent to the fracture surface, measuring approximately 11 mm in length across the tube and 1 mm in width. The other side of the fracture (the longer piece of tube) showed a narrow band of abrasion approximately 2 mm wide by 6 mm long also containing brown coloured particles."

1.16.3 The Director made the following comments:

"The microstructure and the harness of both the front and rear stabiliser support strut components are metallurgically satisfactory for an alloy of this type and heat treatment. The chemical analysis of the rear stabiliser support strut confirms the specification to conform to AISI 6061.

The x-ray map analysis result (iron) of the deposits evident within the indentations evident on the surface of the rear stabiliser support strut, is indicative of ferrous corrosion residues, the result of contact with a ferrous object. The damage was evident on the rear strut underside surface.

The failure of the rear stabiliser support strut, would appear to be the result of a reduction in the compressive strength of the strut due to the damage sustained prior to the accident. The intergranular corrosion revealed in the fracture examination was in the compressive side of the fold and probably played no part in the initial failure. The failure of the rear strut may have overloaded the front support strut, which showed no evidence of prior damage, resulting in the subsequent ductile overload failure of this part."

1.16.4 In conjunction with an investigation into the circumstances of an earlier fatal accident involving a Challenger II Microlight aircraft (Ref:

Report No. 87-081), a series of flight tests were carried out using an aircraft made available by the manufacturer's New Zealand agent, Messrs Wright Products and Services. The purpose of these tests, which were conducted in association with the Auckland Industrial Development Division of the Department of Scientific and Industrial Research (AIDD/DSIR), was to determine the relative magnitude of the load on the struts supporting the horizontal tailplane, under varying flight conditions.

1.16.5 Strain gauges were installed on the front and rear struts supporting the right horizontal tailplane, near to their fuselage attachment brackets. The signals from these gauges were amplified and recorded by equipment carried on the rear seat of the aircraft.

1.16.6 The flight tests provided information regarding the loading on the struts during take-off, climb and in straight and level flight. In addition load data was obtained during "pull-up" and "nose-over" manoeuvres for a range of airspeeds between 30 mph and 80 mph and during 360° turns to the left and right at an airspeed of 50 mph. A static calibration was performed using weights placed at various positions on the right tailplane.

1.16.7 Analysis of the results showed that the peak strain levels recorded during the flight tests corresponded to a maximum load of 230 Newtons (tension) in the front strut during a 360° turn to the left and 207 Newtons (compression) in the rear strut, during a "pull-up"/nose-over manoeuvre. In the latter manoeuvre the maximum compressive load in the front strut was 127 Newtons, the rear strut thus reacting some 62% of the total load. These loads were representative only as the comparative position of the centre of gravity between the aircraft used for the flight tests and ZK-RJX was not established.

1.16.8 Calculation based on the Euler column strength of the rear tailplane strut indicated that it would be capable of sustaining a load of approximately 1485 Newton before failure in buckling. Thus the strength of an undamaged support strut appeared more than adequate to carry the flight loads likely to be imposed upon it. This conclusion was consistent with information provided by the United States manufacturer of the Challenger II aircraft which indicated that during static structural tests of the tailplane, a load of 100 pounds was applied at the tailplane tip without permanent deformation. Such a load would have generated approximately 2000 Newton to be shared between the front and rear spars.

1.16.9 It was evident, however, that the effect of offset loading, if the strut was slightly bent or dented, would significantly increase the stress levels and the strut could be expected to fail under a considerably reduced loading.

1.16.10 The existing area of damage on the right rear tailplane support strut of ZK-RJX would have pre-disposed the strut to fail under a reduced load. It was not practicable, however, in the absence of precise knowledge of the extent of damage, to estimate the actual load at which failure of the damaged strut was likely to occur.

1.17 Additional information

1.17.1 Challenger II ZK-RJX was a single engined, high wing, strut braced microlight aeroplane, employing a "conventional" three-axis control system. Seating for two occupants was arranged in tandem. The instrument panel and flying controls were suitably located for normal operation of the aircraft from the front seat position.

1.17.2 The Owners Manual for the Challenger II contained the following information under the section Airframe Maintenance: (reproduced in part only)

"The following recommended maintenance will help keep your Challenger in airworthy condition ...

TUBING:

Inspect tubing for cracks, dents, elongated holes or distortion in tube surface. Never try to repair a damaged tube! Always replace it with a new part. ...

... TAIL SURFACES, WING FRAMES AND STRUTS:

Inspect holes for elongation. Check for loose rivets and damaged tubing. Replace if necessary. Struts should be free of dents, nicks and scratches. ..."

2. ANALYSIS

2.1 Just before the accident, ZK-RJX was observed in cruising flight at an estimated height of some 400 feet to 500 feet above ground level. When first sighted the aircraft appeared to be operating quite normally. It had departed from a private airstrip located on a nearby farm and the flight path was consistent with the known intention of the two occupants to fly direct from the airstrip to Gore Aerodrome. The relatively low height at which the route was being followed was not unusual, in view of the type of aircraft, the short distance to be flown and the lower terrain which would be traversed over the latter part of the route.

2.2 The aircraft had performed satisfactorily when flown by another pilot earlier in the afternoon and also during a subsequent passenger flight conducted by Mr Cunningham. The take-off, turn and climb after leaving the airstrip, which preceded the accident, was observed by ground witnesses and also recorded on video. There was no indication to suggest any control difficulty or degradation of the aircraft's performance, or the capabilities of the pilot, during the take-off or departure phase.

2.4 Mr Cunningham, who was flying ZK-RJX at the time of the accident, was suitably qualified to act as pilot in command of the flight. His total flying experience in microlight aircraft could not be precisely determined (due to the lack of recorded flight time) but it was evident that he had flown ZK-RJX on a number of previous occasions including a flight in the aircraft with a passenger, on the afternoon that the accident

occurred. It was reasonable to conclude that he was sufficiently familiar with the operation and handling of ZK-RJX, with two persons on board, to have experienced little difficulty, under normal circumstances, in controlling the aircraft or in reacting promptly to any adverse condition or emergency situation.

2.5 As an experienced, locally based, flying instructor during the preceding five years, Mr Cunningham could have been expected to be familiar with the area over which ZK-RJX was flying when the accident occurred and to be aware of the effects of low level turbulence and "wind shear" resulting from penetration of the "sea breeze" inland. It was evident that the prevailing meteorological conditions involving high temperatures and a convergence zone in the area may have been conducive to general thermal instability, wind shear, or the development of isolated "willy willys". However the actual weather reported by local witnesses indicated that the existing conditions were not unduly severe. The handling characteristics of ZK-RJX were such that it was unlikely that a sudden complete loss of control would have resulted solely from the effect of the existing meteorological conditions, unless turbulence, thermal activity, or the pilot's resulting control inputs precipitated a failure in the structure or control systems of the aircraft.

2.6 The farmer who observed ZK-RJX enroute, considered that the aircraft was in level, cruising, flight. It then "tilted to the left" and descended steeply towards the ground. Although there was flat land suitable for an emergency landing within gliding distance of the aircraft's position at the time, the aircraft continued to descend at a steep angle with no evidence of any control input. The angle of descent and heading at impact, together with the severity of the impact forces, indicated that ZK-RJX had not been recovered from the observed descent before it struck the ground.

2.7 It was most likely that the aircraft's unexpected departure from straight and level cruising flight and subsequent steep descent had resulted from some sudden "in-flight" occurrence. In this regard the circumstances surrounding the accident suggested two main possibilities:

In flight structural failure,

In flight pilot incapacitation.

2.8 Examination of the wreckage following the accident disclosed no evidence of control system failure or malfunction, engine problem, or propeller failure prior to the accident. The majority of damage which had occurred to the structure was consistent with the severity of the ground impact forces. One notable exception, however, was the damage known to have been sustained at an earlier stage by the rear support struts of the horizontal tailplane.

2.9 The right horizontal tailplane had folded downwards during the accident sequence due to complete fracture of the rear support strut and a consequential failure of the forward support strut. Whether these struts failed as a result of ground impact loads, or in flight, was not established. If failure of the support struts had occurred in flight, loss of tailplane

effectiveness (download) may have resulted in a nose-down pitch and a steep descent from which the aircraft could not be recovered.

2.10 Data obtained from the series of flight tests carried out after the accident indicated that the strength of an undamaged support strut would have been more than adequate to sustain normal flight loads. It was evident, however, that any surface damage or denting would pre-dispose the strut to fail at a reduced loading.

2.11 In view of the meteorological conditions the possibility could not be eliminated that the reaction of the aircraft, or the pilot's control input, in response to a sudden gust or localised area of turbulence may have produced loads on the horizontal tailplane and elevator combination sufficient to fail the already weakened right rear support strut, followed by failure of the front support strut.

2.12 However, while it could not be proven, the balance of evidence, including the results of in-flight and static load tests on the tailplane, suggested that the failure of both the front and rear struts was most likely to have occurred on ground impact.

2.13 No indication was found to suggest that pre-impact failure had occurred in any other part of the structure of ZK-RJX. Attention was therefore focussed on the medical aspects relating to Mr Cunningham, who had sole control of the aircraft.

2.14 The results of the autopsy disclosed that, at the time of the accident, Mr Cunningham was suffering from the rare disease "chronic sarcoidosis". There was no evidence that he was aware of his illness nor was there any evidence to have alerted the various medical practitioners who examined Mr Cunningham for the issue or renewal of his pilot's licence, or those who assessed the medical information so obtained, to the presence of the disease.

2.15 The medical findings presented a significant probability that the accident to ZK-RJX occurred as a result of pilot incapacitation. Chronic sarcoidosis carried a distinct risk of sudden death and it was entirely possible that Mr Cunningham collapsed while the aircraft was in cruising flight, leading to an uncontrolled roll to the left and nose pitch down.

2.16 As pilot in command, Mr Cunningham occupied the front seat of ZK-RJX. The aircraft had been partially configured for "dual control" operation but no control column was installed in the rear position nor were the rear rudder pedals connected. The throttle was the only effective control readily available to the occupant of the rear seat. Mr Cross, the owner/builder of ZK-RJX, who occupied this position, was well experienced in flying the aircraft, but if Mr Cunningham had suddenly collapsed and the aircraft had pitched nose-down and entered a descent, the pilot's body would have impeded any effort by Mr Cross to recover control of the diving aircraft. In addition, any significant forward movement by the rear seat occupant in an attempt to manipulate the pilot's controls was likely to have increased the pitch down moment, further delaying recovery. In the event, the limited height available may

have precluded the recovery of ZK-RJX from its steep descent before ground impact occurred.

3. FINDINGS

3.1 The pilot in command on the accident flight held a valid Commercial Pilot Licence and "B" Category Instructor Rating and was qualified to fly the aircraft.

3.2 The rear seat occupant was the aircraft's owner/builder who held a valid Advanced Pilot Certificate and was also qualified to fly the aircraft.

3.3 At the time of the accident the flying controls available to the front seat occupant were the only flying controls installed in the aircraft.

3.4 The mass of the aircraft on the accident flight was below the maximum authorised.

3.5 The right rear support strut for the horizontal tailplane had been weakened by severe denting several days before the accident flight.

3.6 The owner knew that the tailplane strut had been damaged before he made the first flight of the day.

3.7 The owner permitted two other pilots and a passenger to fly in the damaged aircraft.

3.8 The Owner's Manual for the Challenger II recommended that any dented tubing be replaced with a new part and in particular the tail surface struts.

3.9 The pilot on the accident flight was aware of the damage to the tailplane strut before he undertook the flight.

3.10 The pilot agreed with the owner's opinion that the aircraft's airworthiness was not compromised by the damage damage to the tailplane strut.

3.11 The tailplane strut failed during the accident sequence resulting in downwards folding of the right tailplane.

3.12 Whether the tailplane strut failed during flight or solely as a result of ground impact loads was not determined.

3.13 The aircraft's Permit to Fly had expired.

3.14 The pilot had been assessed as fit after regular, routine, medical examinations for the issue of pilot licences by a variety of doctors between November 1975 and his last examination on 1 December 1987.

3.15 Autopsy revealed that the pilot in command was suffering from chronic sarcoidosis and was at risk of sudden collapse or death.

3.16 Chronic sarcoidosis was difficult to diagnose and was not likely to be discovered during the routine medical examinations required for the issue of Commercial Pilot Licences.

CONCLUSION

The probable cause of this accident was the inability of the pilot's medical examiners to detect a chronic disease which caused the sudden collapse or death of the pilot in flight and resulted in the aircraft rolling to the left and entering an uncontrolled steep descent from which it could not be recovered by the rear seat occupant before it struck the ground.

The significance of the weakened right rear support strut for the horizontal tailplane, in relation to this accident, was not established. The possibility that in-flight failure of the strut occurred could not be eliminated.

4. SAFETY RECOMMENDATIONS

4.1 The accident may have been caused by pilot medical incapacitation due to chronic sarcoidosis. In view of the risk of sudden severe and unheralded symptoms or sudden death as the result of chronic sarcoidosis, the need was considered for more intensive screening to detect the disease while still in its pre-symptomatic stage.

4.2 Sarcoidosis is a multisystem disorder that affects one or more organs in the body. In its more common form, acute sarcoidosis, symptoms are clinically obvious and develop quickly. Those affected are often quite unwell, but are usually diagnosed promptly and treated. It is unlikely that a patient with acute sarcoidosis would feel well enough to want to fly and medical advice would be against flying as aircrew with this condition.

4.3 On the other hand chronic sarcoidosis usually has no early symptoms and may be very difficult to detect. An affected person could be at risk of sudden cardiac death for as long as 3 years before involvement of other organs is detectable either as the result of symptoms noticed by the person or by abnormalities detected on a clincial examination. Sudden cardiac death is only a potential hazard for affected individuals who have chronic sarcoidosis involving the heart. However, sudden death is the first presentation of chronic sarcoidosis in 15% of those with heart involvements and there are no other features that indicate the presence of chronic sarcoidosis or risk of sudden death.

4.4 In cases of chronic sarcoidosis, chest X-ray changes are common. However it is considered that routine, regular, chest X-ray examinations of all aircrew would involve unnecessary exposure to radiation to large numbers of pilots, to detect less than one case of sarcoidosis per year. The presence of chest X-ray changes does not mean, necessarily, that heart involvement has occurred and further investigation is needed. Only a small proportion of those with chronic sarcoidosis have heart disorders.

4.5 Myocardial sarcoidosis gives rise to detectable abnormalities on the electrocardiogram. All holders of licences issued by the Ministry of Transport are required to have periodic electrocardiography, primarily for the detection of ischaemic heart involvement in the disease, but this also detects myocardial sarcoidosis.

4.6 Chronic sarcoidosis is less common in individuals under the age of 40. Since the frequency of routine electrocardiography is increased at that age (for both professional and private pilots) it is not desirable that the frequency of electrocardiography be increased, to detect chronic myocardial sarcoidosis specifically, unless there is a family history of sarcoidosis.

4.7 The rarity of the condition and the small number of cases of pilot incapacitation from any medical cause, compared to the frequency of accidents due to non-medical causes, suggested that the difficulty in detecting chronic sarcoidosis is not a signficant flight safety hazard.

M F Dunphy
Chief Commissioner