



NO. 94-011

DE HAVILLAND DHC-1 CHIPMUNK

ZK-TNR

WANAKA AERODROME

3 APRIL 1994

ABSTRACT

During an aerobatic display at Wanaka on 3 April 1994 De Havilland Chipmunk, ZK-TNR, collided with the ground killing the pilot.

TRANSPORT ACCIDENT INVESTIGATION COMMISSION

AIRCRAFT ACCIDENT REPORT NO. 94-011

Aircraft Type, Serial Number and Registration:	De Havilland DHC-1 Chipmunk, MK 22A, C1-0018, ZK-TNR
Number and Type of Engines:	1 De Havilland Gipsy Major 10 MK 2
Year of Manufacture:	1950
Date and Time:	3 April 1994, 1340 hours*
Location:	Wanaka Aerodrome Lat: 44° 43'S Long: 169° 15'E
Type of Flight:	Private (Air Display)
Persons on Board:	Crew: 1 Passengers: Nil
Injuries:	Crew: 1 Fatal
Nature of Damage:	Substantial
Pilot in Command's Licence:	Private Pilot Licence (Aeroplane)
Pilot in Command's Age:	46
Pilot in Command's Total Flying Experience:	1454 hours, 200 on type
Information Sources:	Transport Accident Investigation Commission field investigation
Investigator in Charge:	Mr D G Graham

* All times in this report are NZST (UTC + 12 hours)

1. NARRATIVE

- 1.1 On the afternoon of Sunday 3 April 1994 the pilot of De Havilland Chipmunk ZK-TNR was carrying out a solo aerobatics display at the Warbirds Over Wanaka Airshow. Toward the conclusion of his display, as the aircraft reached a position opposite the Display Grandstand and after the completion of an aileron roll to the left, the pilot rolled ZK-TNR to the right to an inverted position and commenced a 'pull-through' (an evolution comprising a half roll around the aircraft's longitudinal axis followed by the second half of a loop resulting in a reversal of the direction of flight with an accompanying loss of height). Insufficient height was available for the manoeuvre to be completed successfully and the aircraft struck the ground and broke up. Nearby personnel including Police, Medical, and Rescue Fire Service crewmen attended the scene immediately, and a Rescue helicopter was made available without delay, but no assistance could be rendered to the pilot who had received fatal injuries.
- 1.2 Warbirds Over Wanaka was an internationally acclaimed Airshow, held every two years during Easter, at Wanaka Aerodrome. The Airshow programme comprised a full day of flying activity, with a Civil display during the morning, an RNZAF display at noon, and from 1300 hours to 1605 hours the "Warbirds Display", a series of flying sequences based on a wide variety of historic military aviation themes ranging from World War I and World War II scenarios, to later conflicts.
- 1.3 The public flying displays at the 1990, and 1992 Airshows, had taken place on Easter Saturday. Friday had been utilised as a practice day for participating pilots. The popularity of the Airshow was such that to allow for the increasing levels of attendance, from within New Zealand and overseas, the 1994 programme had been arranged to provide a full flying display for the public on both Saturday and Sunday with an essentially similar programme scheduled for each day. Friday had remained as the practice day.
- 1.4 The "Warbirds Display" programme for the 1994 Airshow commenced with "TRAINERS", scheduled from 1300 hours to 1330 hours, incorporating a massed formation flypast of Harvard aircraft, followed by the "Roaring Forties" Aerobatic Team displaying Harvards, and concluding with the De Havilland Chipmunk aircraft type.
- 1.5 The Chipmunk display featured two aircraft, programmed to take-off together and land together but presenting individual displays. After take-off the leading Chipmunk made a series of flypasts and demonstrated the aircraft's general handling characteristics while the pilot of the second aircraft, ZK-TNR, climbed to a suitable position and altitude, north of the aerodrome, for the solo aerobatic display.
- 1.6 The display pilots maintained normal air/ground RTF communications with the Airshow Flying Controller (a Warbirds Association member seconded to the Airways Corporation of New Zealand for the Warbirds Display, and operating from the ACNZ Control Caravan temporarily set up at the aerodrome for the duration of the Airshow). In addition, the pilot of the leading Chipmunk maintained RTF contact with the pilot of ZK-TNR to co-ordinate their flying and to enable the conclusion of the Chipmunk handling demonstration to coincide with commencement of the aerobatic sequence. During the display by ZK-TNR the leading Chipmunk loitered in a suitable "holding pattern" at about 1000 feet agl, south-east of the aerodrome. The pilot anticipated that the aerobatic portion of the display would be concluded with a stall turn as on the Saturday, and that the pilot of ZK-TNR would advise him by RTF prior to this manoeuvre so that the two aircraft could subsequently form up with a minimum of delay and return to the aerodrome for a paired landing.
- 1.7 RTF communications with the Airshow Controller were conducted for both aircraft by the pilot of the leading Chipmunk. No communications other than routine acknowledgement of take-off instruc-

tions and in-flight clearance for the display were received from ZK-TNR. No indication was given to the pilot in the leading Chipmunk by the pilot of ZK-TNR of any departure from the programme as flown on the Saturday. No RTF call was received from ZK-TNR to signal that the pilot was about to conclude his aerobatic display.

1.8 The accident was observed by many members of the public including experienced aviation personnel. A number of video records were obtained which facilitated detailed analysis of the aircraft's final manoeuvre. Video footage was also made available of the display by ZK-TNR at the Airshow the previous day (Saturday 2 April 1994), and the pilot's display in ZK-TNR at the North Shore Airshow, near Auckland, approximately one month earlier.

1.9 The aerobatic display by ZK-TNR commenced with a loop at an estimated height of some 2000 feet agl followed by a series of manoeuvres including a stall turn to the right and barrel rolls to the right and left. Climbing turns between the various manoeuvres maintained the overall display pattern at a probable height of about 1500 feet agl. The display was initially conducted just to the north of the aerodrome with the manoeuvres suitably contained, vertically and horizontally, providing good viewing for the majority of spectators located on the aerodrome at the southern side of the sealed main runway, (oriented 290°M/110°M), and on the adjacent hill side to the south. However, as the display continued, and after completing a barrel roll to the left, the pilot flew ZK-TNR toward the west. A half roll and pull-through was carried out at the western end of the aerodrome, and the pilot aligned ZK-TNR for a run-in toward the east. The pilot followed the defined display line, as was required, tracking parallel to the runway and maintaining a flight path above the grass strip on the runway's northern side, furthest from the spectators.

1.10 The aircraft's height during the run-in could not be established precisely but was probably 600 to 700 feet agl. Shortly after levelling out following the half roll and pull through the pilot carried out an aileron roll through 360° to the left. This occupied approximately 6 seconds. The aircraft was then flown in straight and level flight for a further period of 5 seconds. Video evidence confirmed that deliberate control inputs were then made to roll the aircraft to the right, and initiate a pull-through from the inverted position. The sequence of control inputs and extent of control deflection were consistent with such a manoeuvre but the entry speed was likely to have been reduced due to the earlier aileron roll and the continued level flight path. Possibly as a consequence of an already reduced entry speed, little nose-up pitch was applied at the commencement of the manoeuvre.

1.11 The aircraft was kept laterally level during the latter stage of the manoeuvre, and up elevator was maintained as the pilot attempted to recover the aircraft to level flight. However, the height at which the manoeuvre had been commenced had surprised a number of observers and from the outset it had appeared marginal for a successful outcome. In the event, despite the pilot's evident efforts to complete the pull-out the aircraft struck the ground in a nose down attitude of about 20°, with considerable downwards velocity.

1.12 Impact occurred on the display line with the aircraft on a heading of about 300° M. The engine scored a 200 mm deep crater in the grass surface and both undercarriage legs were forced upwards and rearwards. The aircraft lofted briefly and the right wing separated about 55 m beyond the point of initial impact. The fuselage, with the engine and left wing severely disrupted but still attached, came to rest after sliding a further 60 m. The accident site was virtually opposite the mid point of runway 29/11, approximately 35 m north of the runway centreline, and some 90 m across the runway from the security fence bordering the display grandstand, private enclosures, and the nearest spectator positions. Aerodrome elevation at the runway mid-point was approximately 1130 feet.

1.13 The pilot, who was seated in the front cockpit was wearing the full shoulder harness installed in the aircraft, and a helmet, but the vertical component of the impact resulted in severe deformation of

the seat pan and consequent loosening of the harness allowed forward movement. The injuries received by the pilot were unsurvivable. Post mortem and toxicological examination did not reveal any medical condition which might have affected the ability of the pilot to control the aircraft.

1.14 The fuselage and both wings, including the fuel tanks mounted in each wing root, showed marked distortion and damage due to the vertical forces involved on ground impact. The fuel tanks had ruptured and a considerable quantity of fuel had escaped from each tank. The available evidence suggested that each tank had contained about 5 gallons at the time of the accident. Damage to the propeller was consistent with sudden engine stoppage as a result of ground impact.

1.15 Front cockpit instrumentation provided the following information:

Airspeed Indicator—trapped reading 82 knots

Vertical Speed Indicator—fully deflected (4000 feet per minute descent)

Altimeter—Subscale set to 960 hPa

(Instrument internal mechanism severely disrupted by impact forces)

No information of significance to the investigation was obtained from the rear cockpit instrumentation. The flaps were up. The position of the throttle and mixture controls was inconclusive due to impact distortion. However, calculation using photographic evidence indicated that the propeller was rotating at about 970 rpm shortly before the aircraft struck the ground, consistent with the engine and propeller in a windmilling configuration. The carburettor heat was selected on. Other switches and controls were positioned in accordance with normal operation of the aircraft.

1.16 The wreckage was removed to a nearby hangar and examined to confirm, as far as practicable, the pre-impact integrity of the structure and flying controls. No evidence was found to suggest any failure in the airframe or any failure or restriction in the primary flying controls which could have contributed to the accident.

1.17 Visual and aural evidence from the video recordings supported a conclusion that the aircraft and engine functioned normally throughout the aerobatic sequence. Using data from the video record, and based on an airspeed of 80 knots, calculation showed that a “pull-through” commenced at approximately 550 feet agl would have closely simulated the accident circumstances. The combination of witness observations, video evidence, and theoretical calculation suggested that ZK-TNR was probably flying at about 600 feet agl when the final manoeuvre was initiated.

1.18 On the day of the accident, a broad south-westerly airstream covered New Zealand. A cold front in this flow had passed over Wanaka at about 0900 hours. Hourly reports from a local Automatic Weather Station indicated that surface winds were between north and west before the front and south-easterly behind it. The south-easterlies were up to 14 knots initially but were 6 knots at 1300 hours. South-west winds prevailed at higher levels veering west at increased altitude.

1.19 It rained during the morning, and there had been some concern that the Airshow might have to be postponed. However, after the passage of the cold front the weather cleared and continued to improve throughout the day. In the early afternoon the reported conditions were “wind light and variable, CAVOK, temperature + 12°C, QNH 1002 hPa”. Witness reports of conditions at the time of the accident confirmed the surface wind direction to be predominantly from the south-east, with light gusts varying in strength from almost calm to an estimated maximum of about 8 knots. The sky was clear.

1.20 De Havilland Chipmunk serial number C1-0018 was a low-wing, single- engine, two-seat monoplane with a fixed undercarriage of the tailwheel type. It was manufactured in 1950 in the United Kingdom and operated by the Royal Air Force as WB 566. After transfer to the civil register, it was later based in Switzerland for many years, and subsequently re-registered in the United Kingdom as G-

AORR. The aircraft was shipped to New Zealand in 1984, registered as ZK-TNR, and issued at that time with a 4 year Certificate of Airworthiness (C of A). The C of A was renewed in 1988, and in 1992 a non-terminating C of A, Private Operations only, was issued. This C of A remained valid provided the aircraft was maintained in accordance with an approved schedule. ZK-TNR had been so maintained.

1.21 The most recent maintenance had comprised a 50 hour inspection carried out on 11 March 1994. The engine's starboard magneto had been replaced at this time. Maintenance Release No. 009419 had been issued at the preceding 100 hour inspection in December 1993 and was valid until 24 December 1994, or 3458 hours total airframe time, whichever occurred sooner.

1.22 The Gipsy Major 10 MK 2 engine in ZK-TNR had been completely overhauled in 1992, prior to installation in the aircraft. It was equipped with a starter and generator. A Fairey Reed fixed pitch metal propeller was fitted. At the time of the accident the engine had run a total of approximately 2249 hours since new and 134 hours since overhaul. Propeller total time in service was not known.

1.23 The aircraft had a total airframe time of approximately 3395 hours. It had flown about 16 hours since the 50 hourly inspection. No deferred maintenance or recorded defects in regard to the airframe, engine, or propeller of ZK-TNR existed at the time of the accident. An entry by the pilot in the aircraft's "time book", following a formation practice flight at Wanaka on 31 March 1994 indicated that the aircraft was performing satisfactorily in all respects.

1.24 The pilot had been an active member of the Air Training Corps, and had commenced initial flying training in Nelson in 1967. Continuing his training later at Ardmore he had obtained a Private Pilot Licence (Aeroplane) in 1971 and a Commercial Pilot Licence (Aeroplane) in 1975. In 1976 he had been issued with a C category Instructor Rating and over the next seven years had instructed regularly at Ardmore and provided flight experience for Air Training Corps personnel. By mid 1983 he had accumulated some 1100 hours flying.

1.25 The pilot had first flown the De Havilland Chipmunk in 1973. He had obtained a type rating in 1975. He was an enthusiast for the aircraft type and between 1975 and 1980 he flew the two examples based at Ardmore on a regular basis. Occasional flights during this period were recorded as "Aerobatics", totalling approximately 7 hours solo and 55 minutes dual aerobatic flying. In 1983 he recorded a total of 7 hours 55 minutes solo flying in the DH 82A Tiger Moth aircraft type as "Aerobatics". From March 1984 to April 1988 the majority of the pilot's flying had been in the non-aerobatic DHC-2 Beaver which he had displayed at various Airshows. He had briefly flown the CT4 Airtrainer type. No aerobatic flying was recorded over this period.

1.26 In December 1988 a syndicate, of which the pilot was a member, had purchased De Havilland Chipmunk ZK-TNR. The pilot had ferried the aircraft from Nelson to Ardmore and all his subsequent flying (with the exception of 30 minutes aerobatics in a Tiger Moth in 1992) had been in ZK-TNR.

1.27 The pilot had recorded aerobatic flying in ZK-TNR, as follows: (reproduced in summarised form)

April to August 1989—"Aerobatics" 3 hours 45 minutes total

December 1990 to January 1991—"Local Aerobatics" 4 hours 40 minutes total of which 2 hours 50 minutes was noted as "Dual Aerobatics"

August 1991 to December 1991—"Local AR Aerobatics" 3 hours 45 minutes total.

The pilot had flown ZK-TNR in the "Warbirds Over Wanaka" Airshow held in April 1992. He had recorded 30 minutes "Aero Practice" at Wanaka on the day before this Airshow, and 35 minutes for the Display itself.

July 1992 to December 1992—"Local Aerobatics" 1 hour 35 minutes total.

In January 1993, the pilot had flown two Dual "Aerobatic Check" flights with the Chief Flying Instructor of the Warbirds Association, for a total of 2 hours 5 minutes. These were the most recent check flights he had undertaken. He had later flown ZK-TNR at an Airshow at Dairy Flat in February 1993. His next recorded Display flying was at Dairy Flat on 5 March 1994.

1.28 Subsequent flying, entered by the pilot in ZK-TNR's time book comprised the following:

31 March 1994	Dunedin to Wanaka	55 minutes
31 March 1994	Formation Practice	45 minutes
1 April 1994	Photography Session	50 minutes
1 April 1994	Display Practice	30 minutes
2 April 1994	Flypast	20 minutes

The Display Flight on Saturday afternoon, 2 April 1994, and the Display Flight on Sunday, 3 April 1994, during which the accident occurred, were estimated to have occupied a total of about 1 hour and 15 minutes.

1.29 The pilot had renewed his Commercial Pilot Licence regularly since issue, but in 1992 had obtained a Private Pilot Licence (Aeroplane) in its place. This licence included the following Ratings:

Flight Radio Telephone Operator
Glider Towing Rating (Aeroplane)
Instructor Category: C

He had been assessed fit at his most recent medical examination in February 1994 and the Class 2 Medical Certificate associated with his Private Pilot Licence remained valid until 22 March 1996, with Nil Restrictions.

1.30 At the time of the accident, the pilot had accumulated a total flying time of 1454 hours, of which 88 hours was dual. He had recorded a total of some 742 hours of Instructing time by mid 1982 when he had ceased regular instructing duties. His total time on De Havilland Chipmunk aircraft was approximately 200 hours. 4 hours 40 minutes of this total was dual. He had flown De Havilland Chipmunk ZK-TNR for a total of about 107 hours 30 minutes.

1.31 Within the first three months of 1994 he had flown about 12 hours 45 minutes (including the accident flight). He had flown approximately 19 hours in the 13 month period preceding the accident. Over the 5 year period 1989 to 1993 the pilot had averaged approximately 18 hours flying per year, all in ZK-TNR.

1.32 "Warbirds Over Wanaka" Airshow 1994 had been approved by the Civil Aviation Authority. Operations were to be conducted in accordance with CASO 9, Part 5, "Air Pageants and Displays". In conjunction with the Airshow approval, specific "Low Level Aerobatic Approval" had been granted for the pilot concerned in the accident to carry out aerobatics in the De Havilland Chipmunk aircraft type to 500 feet agl. (A similar 500 feet agl approval applied to other New Zealand Warbirds Association members participating as display pilots in the Airshow, and flying a variety of different aircraft types. Two other categories of approval granted to various individuals, were "aerobatics to 1000 feet agl", and "handling to 500 feet agl".)

1.33 Civil Aviation Safety Order 9, Part 5, "Operational conditions" included the following paragraphs:

"5.7.1 Pilots shall ensure that all flying manoeuvres comply with the requirements of the Civil Aviation Regulations 1953, the appropriate Civil Aviation Safety Order, and are carried out in accordance with their approvals ...

5.7.6 All flights shall comply with Regulation 38 Minimum Safe Heights, unless otherwise approved ...”

1.34 As an approved display pilot, the pilot of ZK-TNR would have been well aware of the aerobatic level to which he was permitted to descend, and the requirement to comply with the conditions of Civil Aviation Safety Order 9, Part 5. Compliance in either case meant that his aerobatic manoeuvres would necessarily be conducted and completed at or above 500 feet agl. Certain manoeuvres (such as the 360° aileron roll), given adequate entry speeds and proper execution could be performed in the De Havilland Chipmunk while maintaining level flight. However a manoeuvre such as the half roll and pull-through, which by its nature involved a significant loss of height, clearly had to be commenced well above the minimum level.

1.35 The pilot’s display at another airshow a month earlier, and his display on the day before the accident had given no significant cause for concern regarding the height at which the aerobatic manoeuvres were performed. On the day of the accident the display had been commenced at an appropriate height and manoeuvres were initially performed at a probable height of some 2000 feet to 1500 feet agl. However, the first half roll and pull through, conducted to the west of the aerodrome, resulted in an estimated height loss of 600 or 700 feet, and would have brought the aircraft much closer to the minimum level. Thus subsequent manoeuvres could only be considered practicable if little or no further height loss was involved.

1.36 The sub-scale value of 960 hPa set on the pilot’s altimeter confirmed that he had adjusted the altimeter to a QFE setting. Such an action was in accordance with his stated practice before an aerobatic flight. As a result, within the tolerances of the instrument and its operating system, the altimeter would have indicated the actual height of the aircraft above the aerodrome elevation. It was probable that the altimeter in ZK-TNR was indicating approximately 600 feet at the time the final half roll and pull-through was initiated.

1.37 While peripheral visual cues, easily observed from the cockpit of the Chipmunk, could have been expected to alert him to the aircraft’s relatively low height, the possibility could not be completely dismissed that during the run-in along the display line the pilot misinterpreted his altimeter indication. Allied considerations included the possible effect of the surrounding mountainous terrain on the pilot’s visual assessment of the height, in addition to pre-occupation with the tasks of maintaining the display line and executing the aileron roll to the left to his satisfaction.

1.38 Although in the circumstances it could be considered unlikely, a perceived impression that the altimeter indicated 1600 feet, or thereabouts, perhaps gained solely from a cursory glance at the instrument panel while concentrating on outside references in flying the aircraft, may have been sufficient to convince the pilot that the ensuing half-roll and pull-through could be completed safely without compromising any height limitations.

1.39 Misreading of three-pointer type altimeters as installed in ZK-TNR has been cited as a factor contributing to previous aviation accidents. Potential for such an error may have been increased by an unexpectedly rapid loss of height as a result of the half-roll and pull-through which preceded the run-in, particularly as the available evidence suggested that the pilot was not accustomed to performing this type of manoeuvre regularly.

1.40 It was reasonable to expect that any pre-planned sequence of aerobatic manoeuvres would have been arranged so that the aircraft did not descend below the lowest permissible height at any time. The accident circumstances, therefore, suggested two main possibilities:

- (a) That the pilot was adhering to a planned aerobatic sequence which included the accident manoeuvre and was misled in regard to the aircraft’s height above the ground, possibly

by misreading the altimeter, or otherwise by erroneously interpreting the available visual cues, as already discussed.

- (b) That the final half roll and pull-through, although pilot initiated and controlled, was not a pre-arranged manoeuvre but formed part of a sequence improvised as the display progressed.

The possibility was also considered that the pilot may have intended to complete an aileron roll through 360° to the right, following the earlier aileron roll to the left, and for undetermined reasons did not persevere beyond the inverted altitude. The video evidence however, indicated that the pull-through from the inverted position was initiated without hesitation, and showed control inputs consistent with co-ordinated and deliberate, rather than inadvertent, action.

1.41 Analysis of the video records of the accident display, and the two previous displays by the pilot, showed that while there was some commonality in the individual manoeuvres performed, a different aerobatic sequence was flown on each occasion. No written programme listing a planned sequence of manoeuvres for any of the displays was found, nor was there any sequence card in the aircraft depicting each manoeuvre in aerobatic shorthand (eg. the Aresti system), or some other manner, which might have assisted the pilot to recall a pre-arranged programme, or prompted him regarding the next manoeuvre. This suggested that the pilot was relying on his memory and previous experience as far as his display sequence was concerned.

1.42 The dangers associated with “improvisation”, or “ad-libbing” in the context of aerobatic and/or display flying have been recognised for many years. A number of accidents at Air Displays and Pageants have resulted from this cause. One method employed by experienced aerobatic and display pilots to reduce any temptation toward improvisation, particularly if operating to a low level, has been to rigorously follow a carefully prepared and well practised sequence, and deliberately avoid any departure from it. (Any essential variation due to unforeseen circumstances would normally be considered only after breaking off the original sequence and climbing to a safe height.) A suitably located sequence card or diagram has proved effective as an in-flight aide-memoire.

1.43 Several experienced aerobatic pilots viewed the video recordings of the pilot’s display flying. Considerable variation was noted in the precision with which individual manoeuvres were carried out during the different displays. No concern was expressed regarding the inherent safety of the manoeuvres reviewed but it was generally agreed that portions of the pilot’s Saturday display did not reach the high standard of polish and precision which he was likely to have sought. This was in line with post-display comment by the pilot himself who had expressed some dissatisfaction with his performance and had indicated his intention to “tighten it up a bit” during the Sunday display.

1.44 The display sequence during which the accident occurred was the only occasion where half roll and pull-through manoeuvres had been recorded as a feature of the displays recently flown by the pilot. The inclusion of two of these manoeuvres in relatively close succession reinforced the likelihood that the final stages of the Sunday display involved improvisation. Their absence in recent displays suggested that the pilot was likely to have been less practised in this particular manoeuvre than in other aerobatic manoeuvres in his display. Consequent potential existed for misjudgment in the pilot’s assessment of the height which might be lost in execution of the manoeuvre and in recovery to level flight. Any departure from optimum handling in terms of entry speed and pitch attitude, due to lack of recent practice was also likely to increase ensuing height loss.

1.45 The pilot had been an enthusiastic member of the NZ Warbirds Association for many years, and maintained an active role as a prominent Committee member.

1.46 His participation as a display pilot had commenced with handling demonstrations of the DHC2 Beaver at NZ Warbirds' Airshows during 1985 and he had continued to display the Beaver during subsequent years, to the end of 1988. The pilot's involvement in aerobatic display flying with DHC1 Chipmunk ZK-TNR followed naturally from this earlier flying and his personal commitment to NZ Warbirds' activity.

1.47 In terms of operational procedures and requirements existing within the NZ Warbirds Association at the time, the pilot's experience and his aviation record, together with his demonstrated ability and observed satisfactory performance at Airshows in which he took part, rendered him eligible for nomination for "low level aerobatic approval". Continued satisfactory display flying served as a basis for on-going clearance at this level each year.

1.48 In conjunction with his responsibilities as a NZ Warbirds Association Committee member, the pilot had organised some of the weekend training sessions in which ground briefings were held covering the basic and advanced principles of display flying. The importance of using a written display routine, and of adhering to it, had been emphasised at these training weekends.

1.49 While the principle of maintaining a set routine, and conversely the hazard of departing from it ("ad-libbing"), was well known within the NZ Warbirds' fraternity, and had been emphasised for a number of years, there were no NZ Warbirds Association rules in place at the time of the accident to ZK-TNR to make such a practice mandatory.

1.50 A similar consideration applied to the maintenance of overall proficiency and currency in regard to aerobatic display flying by members of the NZ Warbirds Association. Rules proposed for adoption by the Association included a display currency guideline. Restrictions could also be imposed on individual pilots by the Chief Flying Instructor dependent on flying currency and experience but no mandatory currency requirements existed at the time of the accident. Nevertheless, NZ Warbirds Association pilots were encouraged to complete an aerobatic check annually, either dual or observed from the ground, and to conduct at least one full practice of their intended routine immediately before an airshow. The frequency of displays during the Airshow season also served to maintain currency and an observed adequate display standard.

1.51 Existing CAA regulations and CASO's; (including CASO 9 Part 5 Air Pageants and Displays) dictated compliance with certain necessary procedures and requirements, but the absence of clearly defined rules specifically addressing the operational aspects of aerobatic and display flying had been of concern to a number of organisations within the NZ Aviation Industry for some time. These organisations included the NZ Warbirds Association, the NZ Aerobatic Club, (NZAC), and the Royal New Zealand Aero Club (RNZAC) which represented Aero Clubs throughout the country.

1.52 An Industry Working Group, comprising representatives from these three major organisations, was assembled in June 1993 to discuss the subject of Aerobatics and Display Flying in New Zealand. The group worked towards constructing a set of guidelines for the Civil Aviation Authority of New Zealand (CAA) Rules Review Committee which would assist in the formulation of appropriate Rules governing Aerobatics and Display Flying as part of the new system of Civil Aviation Rules progressively being introduced.

1.53 This consultative document had not been completed at the time of the accident but it was submitted to the Policy and Standards Development section of CAA in May 1994. The purpose was to assist CAA in the task of producing the new Rules, and preserve and reinforce the Aviation Industry's interest in, and concern for, flight safety.

1.54 The accident to ZK-TNR involved an uncharacteristic departure by the pilot from previously observed and accepted aerobatic routines. This culminated in the initiation of a pull-through manoeuvre.

vre, for reasons which could not be established, which took the aircraft significantly below an existing height limitation of which the pilot could be expected to be well aware. In the circumstances it cannot be known whether modified, or additional, procedures within the NZ Warbirds Association organisation would have assisted in averting this particular accident.

1.55 Positive benefits were likely to result, however, from the establishment by the CAA of Civil Aviation Rules directly related to Aerobatics and Display Flying. Suitable guidelines and directives as suggested by the Industry Working Group, including emphasis on adherence to a planned display routine, and maintaining at least a minimum level of currency and proficiency were likely to be contained within such rules. This would provide incentive and authority for organisations such as the NZ Warbirds Association, the NZ Aerobatic Club, and the RNZAC to promulgate the rules to individual members and incorporate them into their own organisational structures with the aim of enhancing the level of safety associated with aerobatics and display flying throughout New Zealand.

2. FINDINGS

- 2.1 The display flight was correctly authorised as part of the Airshow programme.
- 2.2 The De Havilland Chipmunk was a suitable aircraft type for the aerobatic display.
- 2.3 The pilot had been approved to conduct aerobatic manoeuvres in the De Havilland Chipmunk to no less than 500 feet above ground level.
- 2.4 No malfunction or defect was found in the aircraft, including its flight control systems, which might have contributed to the accident.
- 2.5 The aircraft's weight and the position of the centre of gravity were appropriate for the display.
- 2.6 The pilot was familiar with the operation of the De Havilland Chipmunk aircraft type and over the last five years had flown ZK-TNR exclusively.
- 2.7 The pilot had displayed ZK-TNR successfully at a number of locations throughout New Zealand, including a similar airshow at Wanaka in 1992.
- 2.8 The pilot's display at Wanaka on the day before the accident, and his display at another Airshow a month earlier, differed in regard to the aerobatic sequence flown. No half roll and pull-through manoeuvres were recorded in either display.
- 2.9 Toward the conclusion of his aerobatic display on Sunday the pilot initiated a half roll and pull-through at a height of about 600 feet above ground level.
- 2.10 The pilot was attempting to pull out of the ensuing dive when the aircraft struck the ground.
- 2.11 The available evidence suggested that the pilot relied on memory and experience in presenting his displays and did not follow a written aerobatic routine.
- 2.12 The pilot's most recent aerobatic check flight had taken place 14 months prior to the accident.
- 2.13 The relatively few hours flown each year, and the lack of recent aerobatic training/check flights limited the opportunity for the pilot to maintain a consistently high level of aerobatic proficiency.
- 2.14 The accident occurred as the result of a decision by the pilot to initiate a half roll and pull-through manoeuvre at a height below the minimum required to ensure successful recovery of the aircraft to level flight. No definitive reason(s) could be established for the pilot's decision to conduct the manoeuvre at such a low height.

2.15 Factors contributing to the accident probably included a combination of the following:

- An uncharacteristic departure from the pilot's recent aerobatic display routines, which, although differing in aerobatic sequence, had been conducted at greater height and had not included half roll and pull-through manoeuvres.
- The absence of a pre-planned programme of aerobatic manoeuvres for the display, and corresponding absence of any in-flight "sequence card", or other prompt, to assist in ensuring that manoeuvres were flown in the planned order, and completed at, or above, the minimum permitted height.
- Misjudgment of the loss of height likely to be involved in completing the half roll and pull through manoeuvre, and/or a mistaken impression regarding the aircraft's height above the ground prior to manoeuvre commencement.

3. SAFETY RECOMMENDATION

3.1 It was recommended to the Director of Civil Aviation that:

The submission by the Aviation Industry Working Group to the Policy and Standards Development section of the CAA regarding Aerobatics and Display Flying in New Zealand be given priority so that the provisions of the submission may be included as a new part, or incorporated in an existing part, of the Civil Aviation Rules, with a minimum of delay (080/94).

7 December 1994

M F Dunphy
Chief Commissioner

ABBREVIATIONS COMMONLY USED IN TAIC REPORTS

AD	Airworthiness Directive
ADF	Automatic direction-finding equipment
agl	Above ground level
AI	Attitude indicator
AIC	Aeronautical Information Circular
AIP	Aeronautical Information Publication
amsl	Above mean sea level
ASI	Airspeed indicator
ATA	Actual time of arrival
ATC	Air Traffic Control
ATD	Actual time of departure
ATPL (A or H)	Airline Transport Pilot Licence (Aeroplane or Helicopter)
AUW	All-up weight
C	Celsius (normally preceded by °)
CAA	Civil Aviation Authority
CASO	Civil Aviation Safety Order
CFI	Chief Flying Instructor
CPL (A or H)	Commercial Pilot Licence (Aeroplane or Helicopter)
DME	Distance measuring equipment
E	East
ELT	Emergency location transmitter
ERC	En route chart
ETA	Estimated time of arrival
ETD	Estimated time of departure
F	Fahrenheit (normally preceded by °)
FAA	Federal Aviation Administration (United States)
FL	Flight level
g	Acceleration due to gravity
GPS	Global Positioning System
HF	High frequency
hPa	Hectopascals
IAS	Indicated airspeed
IGE	In ground effect
IFR	Instrument Flight Rules
ILS	Instrument landing system
IMC	Instrument meteorological conditions
ins Hg	Inches of mercury
kHz	Kilohertz
KIAS	Knots indicated airspeed
kt	Knot(s)
LF	Low frequency
LLZ	Localiser
M	Mach number (e.g. M1.2)

M	Magnetic (normally preceded by °)
MAANZ	Microlight Aircraft Association of New Zealand
MAP	Manifold absolute pressure (measured in inches of mercury)
MAUW	Maximum all-up weight
METAR	Aviation routine weather report (in aeronautical meteorological code)
MF	Medium frequency
MHz	Megahertz
mph	Miles per hour
N	North
NDB	Non-directional radio beacon
NOTAM	Notice to Airmen
nm	Nautical mile
NZAACA	New Zealand Amateur Aircraft Constructors Association
NZGA	New Zealand Gliding Association
NZHGPA	New Zealand Hang Gliding and Paragliding Association
NZMS	New Zealand Mapping Service map series number
NZDT	New Zealand daylight time (UTC + 13 hours)
NZST	New Zealand standard time (UTC + 12 hours)
NTSB	National Transportation Safety Board (United States)
OGE	Out of ground effect
PAR	Precision approach radar
PIC	Pilot in command
PPL (A or H)	Private Pilot Licence (Aeroplane or Helicopter)
psi	Pounds per square inch
QFE	An altimeter subscale setting to obtain height above aerodrome
QNH	An altimeter subscale setting to obtain elevation above mean sea level
RNZAC	Royal New Zealand Aero Club
RNZAF	Royal New Zealand Air Force
rpm	revolutions per minute
RTF	Radio telephone or radio telephony
S	South
SAR	Search and Rescue
SSR	Secondary surveillance radar
T	True (normally preceded by °)
TACAN	Tactical Air Navigation aid
TAF	Terminal aerodrome forecast
TAS	True airspeed
UHF	Ultra high frequency
UTC	Coordinated Universal Time
VASIS	Visual approach slope indicator system
VFG	Visual Flight Guide
VFR	Visual flight rules
VHF	Very high frequency
VMC	Visual meteorological conditions

VOR
VORTAC
VTC
W

VHF omnidirectional radio range
VOR and TACAN combined
Visual terminal chart
West