TRANSPORT ACCIDENT INVESTIGATION COMMISSION
TE KOMIHANA TIROTIRO AITUA WAKA

AIRCRAFT ACCIDENT REPORT

No. 90-039

NORTH AMERICAN AVIATION INCORPORATED
HAVARD 2A* (AT6)
ZK-ENN

Ardmore Aerodrome, Auckland Province

25 February 1990

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 North American Aviation Incorporated Harvard 2A* (AT6) ZK-ENN at Ardmore Aerodrome on 25 February 1990 and includes suggested findings and recommendations.

This report is submitted pursuant to Section 8(2) of the Transport Accident Investigation Commission 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.

24 June 1991

R CHIPPINDALE
Acting Chief Executive

APPROVED FOR RELEASE AS A PUBLIC DOCUMENT

16 July 1991

M F DUNPHY
Chief Commissioner

AIRCRAFT:	North American Aviation Incorporated Harvard 2A* (AT6)	**OPERATOR:**	J. Greenstreet
REGISTRATION:	ZK-ENN	**PILOT:**	J. Greenstreet
PLACE OF ACCIDENT:	Ardmore Aerodrome, Auckland Province	**OTHER CREW:**	Nil
DATE AND TIME:	25 February 1990, 1823 hours	**PASSENGERS:**	Nil

SYNOPSIS:

The Office of Air Accidents Investigation was advised of this accident on 25 February 1990 at 1900 hours. The Chief Inspector of Air Accidents commenced his onsite investigation on 26 February 1990. The aircraft, number 4 in a formation "bomb burst" manoeuvre, collided with number 3 aircraft in the formation. After the collision the number 4 aircraft dived straight into the ground while the pilot of number 3 was able to make an emergency landing. The pilot of number 4 aircraft was killed in the accident.

1.1 HISTORY OF THE FLIGHT:	1.2 INJURIES TO PERSONS:	1.3 DAMAGE TO AIRCRAFT:	1.4 OTHER DAMAGE
See page 4.	Pilot: Fatal	Destroyed	See Page 6.

1.5 PERSONNEL INFORMATION:

See page 6.

Flight Times

	Last 90 days	Total
All Types	23	415
On Type	21	218

1.6 AIRCRAFT INFORMATION:

See page 7.

1.7 METEOROLOGICAL INFORMATION:	1.8 AIDS TO NAVIGATION:	1.9 COMMUNICATION:
See page 8.	Not applicable	See page 8.

1.10 AERODROME:	1.11 FLIGHT RECORDERS:	1.12 WRECKAGE AND IMPACT INFORMATION:
See page 9.	Not applicable	See page 9.

1.13 MEDICAL AND PATHOLOGICAL INFORMATION:	1.14 FIRE:	1.15 SURVIVAL ASPECTS:
There was no evidence of any physiological or toxicological condition which may have affected the pilot's ability to conduct the flight.	No fire occurred.	The accident was unsurvivable.

1.16 TESTS AND RESEARCH:	1.17 ADDITIONAL INFORMATION:	1.18 USEFUL OR EFFECTIVE INVESTIGATION TECHNIQUES:
See page 9.	See page 9.	Nil.

2. ANALYSIS:	3. FINDINGS:
See page 12.	See page 14.

4. SAFETY RECOMMENDATIONS:	5. APPENCIES:
See page 14.	Nil

* All times in this report are NZDT (UTC + 13 hours)

1. FACTUAL INFORMATION

1.1 History of the flight

1.1.1 On the morning of the accident Mr Greenstreet flew ZK-ENN to Dairy Flat from Kerikeri where he had flown some four hours, on the previous day, in support of a film production.

1.1.2 He spent part of the day at the beach with his family before returning home and resting.

1.1.3 He was aware that the briefing for a formation aerobatic display practice was scheduled for 1600 hours but was still at home at that time and was unenthusiastic about driving to Dairy Flat to fly his aircraft to Ardmore to participate in the practice.

1.1.4 Mr Greenstreet had telephoned earlier that he would be a little late and the team leader had agreed to wait for him. When he arrived at Ardmore, close to 1715 hours, he found that his T28 aircraft had been pushed out of the hangar and the wind was tearing its covers.

1.1.5 Mr Greenstreet was upset by this situation and the formation team leader, who described his reaction as being "absolutely furious", asked him if he was fit to fly. He replied that he was "okay" but when pressed admitted he was a little tired. He then refuelled ZK-ENN before returning for the briefing.

1.1.6 Ardmore Tower were anxious for the formation practice to start and a telephone call was received part way through the briefing asking for the team to be airborne in five minutes. This was not practicable so the briefing continued.

1.1.7 At approximately 1730 hours the formation briefing was completed. This did not involve a "blackboard and chalk" but a verbal briefing was considered adequate as this was to be the fifth practice for the team and comprehensive briefings had been held before each of the previous practices.

1.1.8 Following the briefing the team climbed into their aircraft and completed a normal start up, taxi and engine run up prior to getting airborne at 1802 hours. Mr Greenstreet was flying ZK-ENN in number 4 position and ZK-ENE was flown in the number three position in a formation of five aircraft. One aircraft broke off from the formation early to conduct a solo routine in coordination with the formation aerobatics of the other four aircraft.

1.1.9. After a few "bumps" on take-off and climb out the flying conditions aloft were smooth.

1.1.10 The display line was parallel to runway 21, except for the "bomb burst" which was on a southerly heading to ensure the two aircraft heading towards the area in which the crowd would be assembled, were aligned to pass well clear of either end of the spectators.

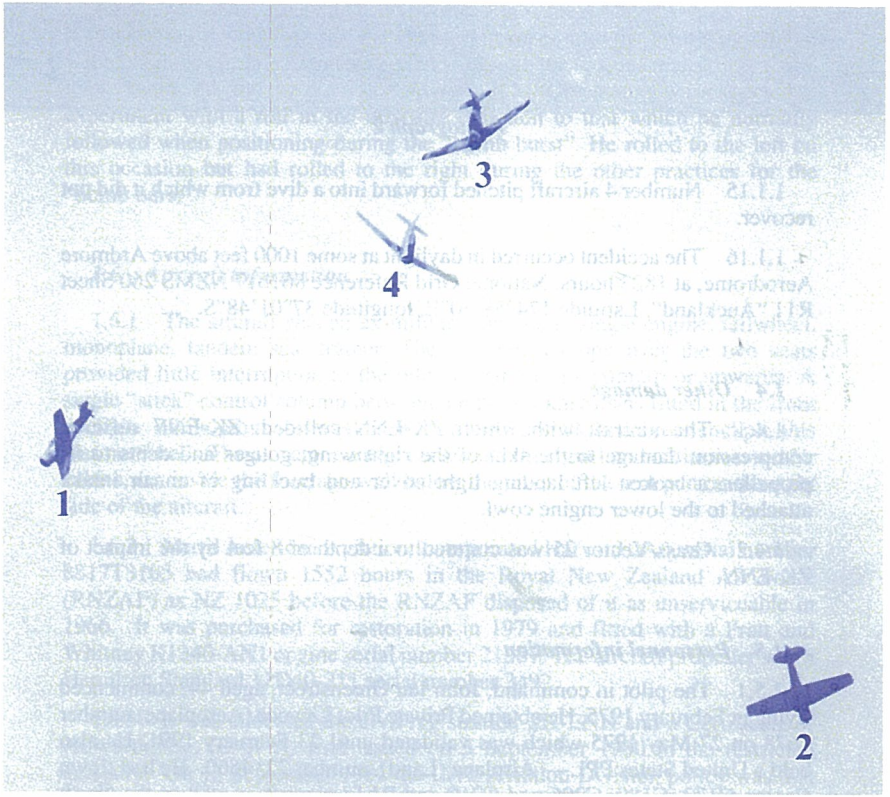
1.1.11 The practice routine proceeded satisfactorily until a stall turn in line abreast for which Mr Greenstreet was out of position and consequently completed an untidy manoeuvre.

1.1.11 The last manoeuvre of the display was a downward "bomb burst" from the top of the loop in a "box" formation. This started with an entry similar to that required for a formation loop but as the aircraft approached the vertical

on the downward portion of that manoeuvre, the leader called, "Break", following which he completed the loop, numbers two and three aircraft which were to his right and left respectively, rolled 90° in opposite directions and pulled up into a horizontal flight path but the pilot of number 4 aircraft, who was intended to roll through 180° in the direction of his choice before pulling the aircraft into a horizontal flight path, hesitated before he began to roll the aircraft. His aircraft was positioned in the "box", i.e. in line astern of the leader and the same distance back from numbers 2 and 3 aircraft as they were back from the leader.

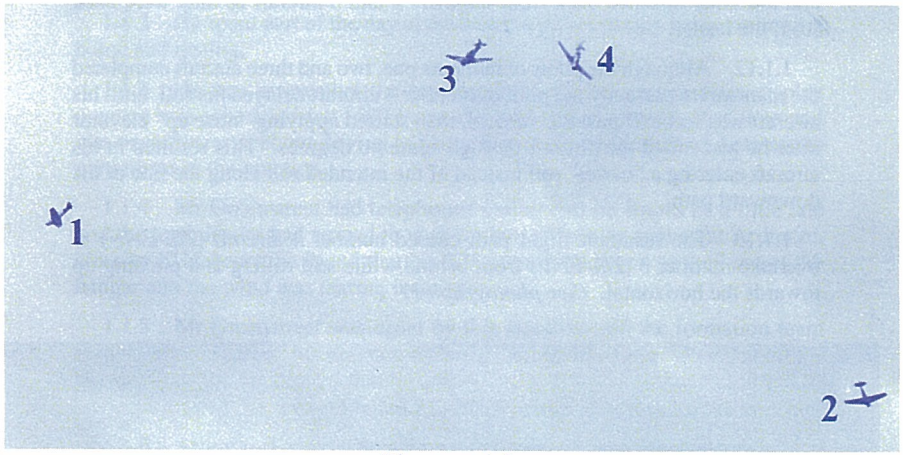
1.1.12 Although the pilots of numbers one, two and three aircraft completed the manoeuvre correctly the pilot of number 4 aircraft delayed his roll, until his aircraft was some 5° past the vertical, then started applying "nose up" elevator after he had rolled the aircraft through some 90 degrees. This resulted in his aircraft entering a "barrel" roll instead of the intended roll along the line of his downward path.

1.1.13 The resultant flight path caused number 4 aircraft (ZK-ENN) to overtake number 3 (ZK-ENE) from behind while still rolling and pitching up towards the horizontal. *(See photograph 1)*



Photograph 1

1.1.14 As number 4 aircraft overtook number 3 it was banked at 90° relative to ZK-ENE and converging on it in a curved flight path. As a result it collided with ZK-ENE and its right hand elevator and horizontal stabiliser were knocked off by that aircraft's right wingtip *(See photograph 2)*. Subsequently ZK-ENN slid beneath ZK-ENE and the propeller of the number 3 aircraft sliced through both elevator control cables and one rudder cable of ZK-ENN.



Photograph 2

1.1.15 Number 4 aircraft pitched forward into a dive from which it did not recover.

1.1.16 The accident occurred in daylight at some 1000 feet above Ardmore Aerodrome, at 1823 hours. National Grid Reference 861617 NZMS 260 Sheet R11 "Auckland". Latitude 174°58'30"E, longitude 37°01'48"S.

1.4 Other damage

1.4.1 The aircraft with which ZK-ENN collided, ZK-ENE suffered compression damage to the skin of the right wing, gouges and dents to its propeller, a broken left landing light cover and buckling of an air intake attached to the lower engine cowl.

1.4.2 Grass Vector 25 was cratered to a depth of 8 feet by the impact of ZK-ENN.

1.5 Personnel information

1.5.1 The pilot in command, John Ian Greenstreet, aged 44, commenced flying in February 1975. He obtained Private Pilot Licence (Aeroplane) number 1678 on 27 May 1975 which was validated until 23 February 1991. He also held a United States PPL — Airplane (Land), number 2254660. He had flown Cessna C172, C180, C206 and C210 and PA18 aircraft as well as the North American Harvard 2A*, Sea Fury and T28 Trojan aircraft.

1.5.2 He had a total of 218 hours on the Harvard including 9 hours dual. He had a total flying experience of 415 hours. In the last 90 days he had flown 23 hours, all but 2 hours in the Harvard aircraft.

1.5.3 He had a total of 8.1 hours' dual instruction in formation flying, aerobatics and formation aerobatics and had completed some 50 hours solo flying aerobatics, some 39 hours of which was in formation. He had approval from the Director of Civil Aviation to fly low level display and practice formation aerobatics to a minimum of 500 feet and for low passes at 100 feet agl.

1.5.4 At his last medical examination on 23 February 1989 he was assessed as fit for the renewal of a PPL for 2 years.

1.5.5 Mr Greenstreet had not flown in the formation aerobatic team in the number 4 position prior to the previous four rehearsals. He had been selected for that position because of his aptitude for this type of flying as it was the more demanding of the formation keeping positions. As was to be expected he had some settling in problems and after a previous practice asked the leader to give him some more height to enable him to complete the turn for the "bomb burst" manoeuvre more comfortably.

1.5.6 Mr Greenstreet had been involved in some discussion regarding the best direction in which to roll the Harvard in relation to the pilot's individual stature and the aircraft's tendency to roll left with the torque created in reaction to the engine driving the propeller. As a result Mr Greenstreet was expected to experiment with a roll in the opposite direction to that which he normally followed when positioning during the "bomb burst". He rolled to the left on this occasion but had rolled to the right during the other practices for the "bomb burst".

1.6 Aircraft information

1.6.1 The aircraft was an ex-military low wing, single engine, tailwheel, monoplane, tandem seat trainer. The common canopy over the two seats provided little interruption to the pilot's visibility in azimuth or upwards. A single "stick" control column between the pilot's knees was fitted in the front cockpit. While provision was made for a similar stick in the rear cockpit, this was not fitted. The elevator control cables and the right hand of the two rudder cables, ran inside the fuselage wall below the level of the seat pan on the right side of the aircraft.

1.6.2 North American Aviation Incorporated Harvard 2A*, serial number 8817T3105 had flown 1552 hours in the Royal New Zealand Air Force (RNZAF) as NZ 1025 before the RNZAF disposed of it as unserviceable in 1966. It was purchased for restoration in 1979 and fitted with a Pratt and Whitney R1340-AN1 engine serial number 21367. The aircraft propeller was a Hamilton Standard 12D40-211 serial number 3492.

1.6.3 It was allocated the civil registration ZK-ENN and a Certificate of Airworthiness (C of A) first issued on 5 September 1980 in the restricted category. On 13 September 1981 the Civil Aviation Division policy was that ex-RNZAF aircraft would be known by their RNZAF name, in this case Harvard, rather than AT6, and the serial numbers would be their military

registration number rather than the manufacturer's serial number. From this date the aircraft serial number was intended to become NZ1025 on all subsequent documentation. This policy was partially successful. An alternative serial number 88-10254 was used on some occasions, the latest being on an Aircraft Certificate of Registration dated 22 December 1987.

1.6.4 A non-terminating C of A was issued on 12 November 1984 in the restricted category for "Private Operations Only" and for "Flight in New Zealand Only".

1.6.5 An annual inspection was completed on the aircraft on 20 November 1988.

1.6.6 The engine and propeller had flown 260.42 hours since overhaul, by November 1989. Both were originally on the RNZAF inventory but the total time since new was not transferred to the civil documentation.

1.6.7 The airframe had completed 1821 hours flying time to November 1989 after which no records were kept for the airframe, engine or propeller but the pilot recorded flights in the aircraft after this time totalling a further 15 hours.

1.6.8 The aircraft had been maintained in accordance with the manufacturer's Maintenance Handbook in conjunction with Schedules AW 69A and 69B. The engine was required to be run weekly but there was no specific record of this being done or of individual flights in the various aircraft logbooks. Monthly totals were all that was recorded from May 1989 to November 1989.

1.7 Meteorological information

1.7.1 A ridge of high pressure lay to the north of New Zealand and a south-westerly airstream flowed over the country.

1.7.2 At Ardmore Aerodrome the surface winds were south-west at about 15 knots. These winds increased to about 20 knots at 3000 feet.

1.7.3 There was a layer of broken strato cumulus at about 2500 feet and another layer with a base at about 4000 feet. Visibility was good beneath the cloud.

1.7.4 There was occasional moderate mechanical turbulence near the ground.

1.9 Communications

1.9.1 The formation aircraft remained on the Ardmore Tower frequency 118.1 MHz throughout the flight. All communication between the aircraft and between the formation leader and the Tower was clear.

1.9.2 Following the in-flight collision a Mayday message was transmitted by the pilot of number three aircraft (ZK-ENE) in the formation and he obtained clearance to land his damaged aircraft downwind as a result.

1.9.3 No transmission was heard from the pilot of number 4 aircraft after the collision.

1.10 Aerodrome information

1.10.1 Ardmore Aerodrome had two bitumen covered runways 21/03 and 25/07 which intersected some 250 m from the approach end of runways 21 and 25. From this intersection two grass vectors extended parallel to and inside runways 21 and 25.

1.10.2 The control tower was located almost centrally in the triangular space between the two grass vectors.

1.10.3 The aerodrome elevation was 110 feet amsl.

1.12 Wreckage and impact information

1.12.1 The main wreckage of ZK-ENN was contained in and about a crater on the approach end of grass vector 25 at Ardmore Aerodrome.

1.12.1 The right rear cockpit area bore evidence of propeller slashes which had cut through the seat pan, safety belt, elevator cables and the right rudder cable.

1.12.3 The right elevator and horizontal stabiliser were located separately from the wreckage having been knocked off in the collision.

1.16 Tests and research

1.16.1 Use of the staff and facilities of the Royal New Zealand Police College enabled a video tape of the flight paths of the four aircraft before and after the collision to be subjected to a frame by frame analysis.

1.16.2 The Police were also able to provide a permanent colour print of each frame of the video record of the collision sequence.

1.16.3 This analysis showed that number 2 and 3 aircraft initiated their roll for the bomb burst slightly before their aircraft were vertical and number 4 aircraft continued slightly beyond the vertical before rolling. The pilot of number 4 rolled it through 90° then started applying up elevator and the consequent flight path lead number 4 aircraft to intercept number 3 as it crossed number 3's flight path in a 90° banked attitude *(See photographs 3, 4 and 5).*

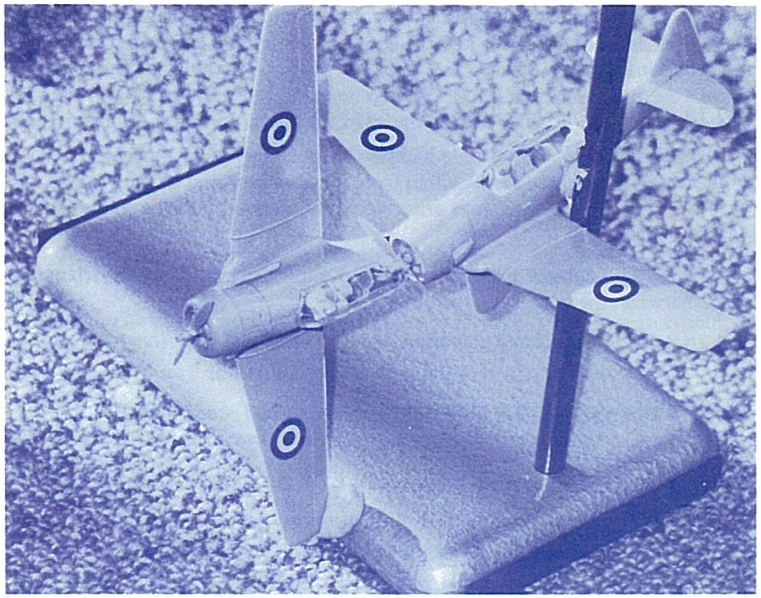
1.17 Additional information

1.17.1 Regulation 39 of the Civil Aviation Regulations (1953) stated in part :

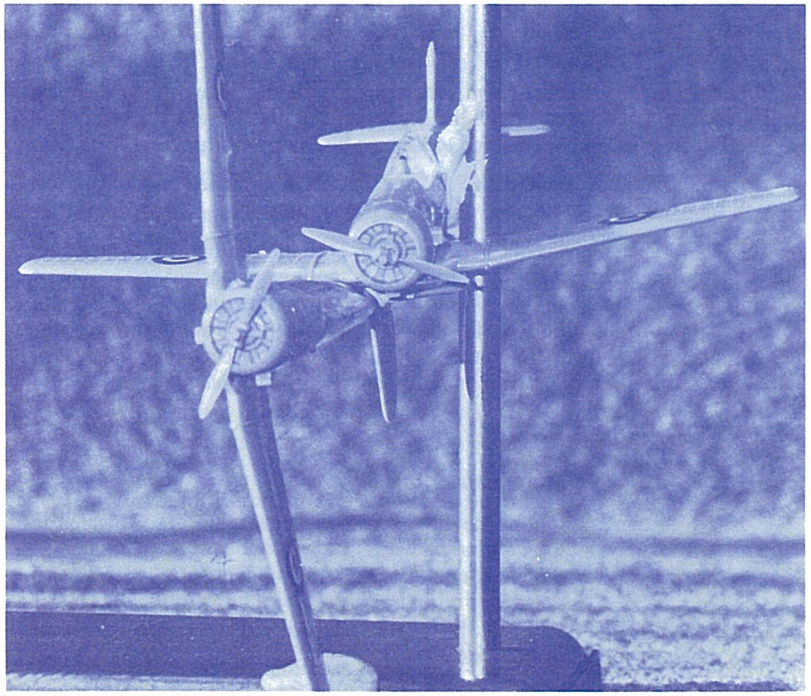
"AEROBATIC FLIGHT

(1) An aircraft shall not be flown aerobatically except in visual meteorological conditions.

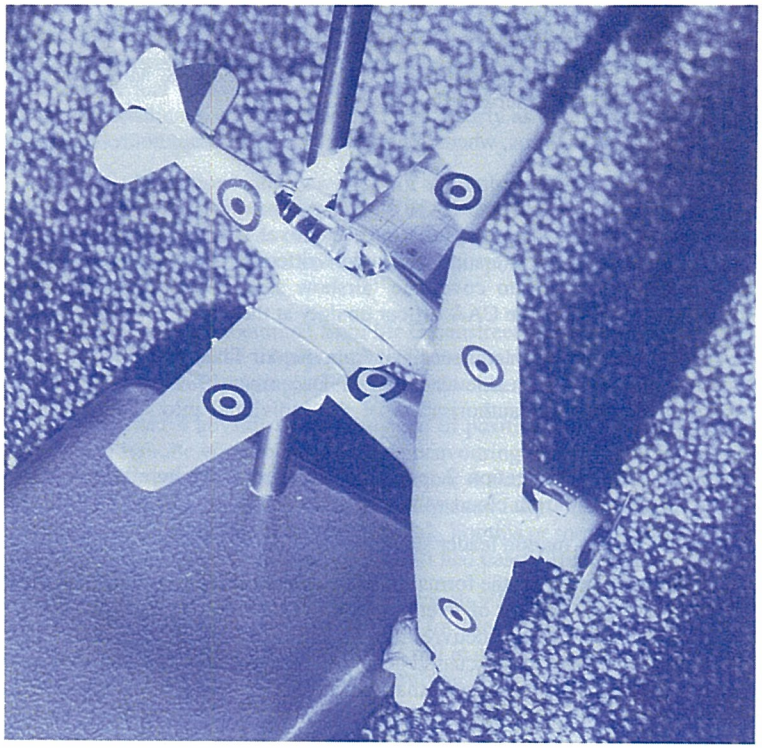
(2) An aircraft shall not be flown aerobatically —



Photograph 3



Photograph 4



Photograph 5

(a) At a height of less than 3000 feet above the terrain unless a lesser height has been approved by the Director,

(b) In the vicinity of any city, town, or populous area . . ."

1.17.2 Civil Aviation Safety Order (CASO) 9 Part 5 stated:

"AIR PAGEANTS AND DISPLAYS

5.7 Operational Conditions

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.

5.7.2 All aircraft shall be flown with reference to a pre-determined display line which shall be no closer than 60 metres (200 feet) from the nearest spectator boundary.

5.7.3 All turns initiated whilst the aircraft is opposite the public enclosure shall be made away from the display line.

5.7.4 Flying over spectator enclosure areas is prohibited.

5.7.5 No passenger shall be carried in an aircraft that is participating at an event unless such a person is part of the essential operating crew.

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

5.7.9 Low runs, where approved, shall be flown at not less than 100 feet agl.

5.7.10 Pilots who wish to carry out aerobatics below 3000 feet agl require specific approval and such approval shall have been arranged prior to the event. Persons who hold written aerobatic approvals which have been issued to cover the 'airshow season' shall be required to produce these to the CAA officer on duty at the event."

1.17.3 Authorisation was received from the Air Transport Division of the Ministry of Transport in a letter dated 11 December 1989 for the aerobatic formation display and authorisation of the individual pilots for low level aerobatics.

1.17.4 CASO 1, Section 2, paragraph 2.3 required aircraft to maintain 1000 feet vertically from cloud within controlled airspace.

1.17.5 The formation leader stated:

"Breaking away from the formation in an emergency was discussed in great depth at the beginning of every season. Members are asked to consider escape routes for all manoeuvres they fly during the routine and some of the more obvious ones are discussed generally. I have never flown at number 4 but Mr Greenstreet discussed that particular position in great detail with experienced pilots who had flown in that position many times and I can only assume that escape paths were discussed. The pilots of the team all knew that they must be aware of an escape option during every second of the routine, and I'm sure Mr Greenstreet was no exception."

2. ANALYSIS

2.1 Mr Greenstreet's delay in reporting for the briefing was probably due to tiredness after his involvement with flying for filming on the previous day and the flight from Kerikeri to Dairy Flat earlier on the day of the accident.

2.2 Mr Greenstreet's weariness plus his anger as a result of finding the covers on his T28 aircraft being damaged by the wind were likely to have affected his ability to fly accurately in the formation.

2.3 The verbal briefing was adequate because it followed four, more comprehensive, briefings and four debriefings associated with previous rehearsals for the display. However some time spent at this briefing or on any other occasion to discuss the action to be taken if the pilot in number 4 aircraft became disoriented during the bomb burst might have paid dividends.

2.4 Disorientation was considered to be a possibility by several pilots who had flown in that position. The formation leader recognised the possibility of manoeuvres going awry but believed that any such situation could be resolved by the individual pilots at the time without the need for any specific briefing.

2.5 The formation leader was conscious of the agitation Mr Greenstreet had displayed immediately prior to the briefing and asked him twice, about his fitness to participate in the formation practice. Although Mr Greenstreet assured him that he had recovered his composure and was ready for the flight this subjective assurance was of little value particularly as on the second occasion he was asked the question in front of his peers.

2.6 The formation leader saw the pilot of number 4 aircraft have difficulty, subsequently, with a stall turn manoeuvre which he normally completed without difficulty, however he was reassured when he noted, later, that the pilot of number 4 aircraft appeared to be maintaining his position beneath the leader's aircraft, competently.

2.7 The accident stemmed from Mr Greenstreet's failure to "unload" the aircraft, i.e. pause in the loop to establish a vertical line, before initiating the 180° roll and in turn applying up elevator before the roll was complete.

2.8 Number 4 aircraft was slightly out of position at the top of the loop which lead into the bomb burst, and in endeavouring to reposition his aircraft the pilot overcorrected. As a result the number 4 aircraft was not in a suitable position for the manoeuvre to be completed successfully, being too close to the leader when he called for the aircraft to break. For this or some other reason Mr Greenstreet delayed his roll until his aircraft had passed the vertical.

2.9 After he had rolled the aircraft through 90° his aircraft was 45° nose down with 90° of bank so it was natural for him to start to pull out of the manoeuvre and stop or slow the aircraft's roll in order to avoid continuing into an inverted 45° dive. The resultant "barrelling" roll took the aircraft towards number 3 with which it collided.

2.10 The subsequent passage of the propeller blades of number 3 aircraft through the right hand side of the rear cockpit of number 4 aircraft deprived Mr Greenstreet of any elevator control or ability to apply right rudder and his aircraft dived into the ground.

2.11 Despite the vibration and loss of efficiency of the propeller due to the damage it sustained in the collision, the pilot of number three aircraft was able to land his aircraft successfully.

2.12 Mr Greenstreet's inaccurate formation flying performance was uncharacteristic. He had asked for more height in which to complete the roll in the "bomb burst" manoeuvre but the situation which led to the accident did not appear to stem from a concern relating to loss of height. Equally it did not appear that the pilot was disoriented in that his aircraft was exiting the formation on approximately the correct heading when the collision occurred.

2.13 Although he had practiced rolling the aircraft to the left in a dive this was the first time he had attempted to roll to the left in a formation of four aircraft. This factor or a general lack of concentration due to the events prior to the practice could have led to his inappropriate attempt to initiate the 180° roll after his aircraft had passed the vertical position in the dive. His action in "barrelling" the roll to escape his predicament was his only option, after he did not follow the leader to complete the loop, other than to reverse the roll.

2.14 Nevertheless it was probable that a collision could have been avoided had the pilot of number 4 aircraft seen ZK-ENE in time. It was evident that Mr

Greenstreet "was pulling hard" as he passed the pilot in number 3 aircraft so he may have lost visual acuity on the verge of a loss of consciousness due to the increased acceleration or simply, have not been expecting any aircraft to be in that vicinity and consequently not maintained an adequate look out.

3. FINDINGS

3.1 The formation practice had been correctly authorised.

3.2 Each pilot involved was authorised for low level aerobatics.

3.3 The formation was correctly briefed for the flight.

3.4 Each aircraft was airworthy for the flight.

3.5 The Harvard aircraft were suitable for the formation flying routine undertaken.

3.6 The pilot of number 4 aircraft may not have been concentrating on the task due to fatigue and/or other factors.

3.7 Number 4 aircraft was rendered uncontrollable by the collision.

3.8 There was no action which the pilot of number 3 aircraft could have taken to avoid the collision.

3.9 The "bomb burst" manoeuvre was not a hazardous manoeuvre if each aircraft was flown correctly.

3.10 The weather was not a factor in the accident.

3.11 The accident resulted from an uncharacteristic error of judgement by the pilot who elected to continue a manoeuvre for which his aircraft was not suitably positioned. Causal factors were; a probable lessening of the visual acuity of the pilot of number 4 aircraft due to increased "G" loading, his unsettled demeanour and fatigue and the absence of a briefing on "escape" procedures for pilots who found themselves out of position for a manoeuvre.

4. SAFETY RECOMMENDATIONS

4.1 As a result of this accident it was recommended that:

The formation team leader considered including in the briefing prior to formation flying a discussion on the action to take if a pilot, particularly the person flying in the number 4 position, became disoriented and

The formation leader rely on his own judgement if he doubted a person's fitness to fly rather than seek a subjective reassurance from that person in front of his peers.

16 July 1991

M F DUNPHY
Chief Commissioner