

AIRCRAFT ACCIDENT REPORT
OCCURRENCE NUMBER 04/940
POTEZ AIR FOUGA CM 170 MAGISTER
ZK-FGA
IN THE FIRTH OF THAMES, NEAR KAIAUA TOWNSHIP
19 MARCH 2004



Glossary of abbreviations used in this report:

ACE	Air show Certification Evaluator
agl	above ground level
AMSL	above mean seal level
AOPA	Aircraft Owners and Pilots Association
ATC	air traffic control
BFR	Biennial Flight Review
CAA	Civil Aviation Authority
CAP	Civil Aviation Publication
CAR	Civil Aviation Rules
CASA	Civil Aviation Safety Authority Australia
CFI	Chief Flight Instructor
E	east
ECG	electrocardiograph
FOD	foreign object damage
hPa	hectopascals
ICAS	International Council of Air Shows
IPC	illustrated parts catalogue
lb	pound(s)
MHz	megahertz
NTSB	National Transportation Safety Board
NZDT	New Zealand Daylight Time
PPL	Private Pilot Licence
RNZAF	Royal New Zealand Air Force
VHF	very high frequency

AIRCRAFT ACCIDENT REPORT

OCCURRENCE No 04/940

Aircraft type, serial number and registration:	Potez Air Fouga CM 170 Magister, 216, ZK-FGA
Number and type of engines:	2 Turbomeca Marbore II F3
Year of manufacture:	1960
Date and time:	19 March 2004, 1016 hours ¹ (approx)
Location:	In the Firth of Thames, near Kaiaua Township Latitude ² : S 37° 06.51' Longitude: E 175° 18.148'
Type of flight:	Private
Persons on board:	Crew: 2
Injuries:	Crew: 2 fatal
Nature of damage:	Aircraft destroyed
Pilot-in-command's licence	Private Pilot Licence (Aeroplane)
Pilot-in-command's age	56 years
Pilot-in-command's total flying experience:	1780 hours, 90 on type
Information sources:	Civil Aviation Authority field investigation
Investigator in Charge:	Mr A M Moselen

¹ All times in this report are NZDT (UTC + 13 hours)

² WGS 84 co-ordinates

Synopsis

The Civil Aviation Authority was notified of the accident at approximately 1045 hours on 19 March 2004. The Transport Accident Investigation Commission was in turn notified shortly thereafter, but declined to investigate. A CAA site investigation was commenced later the same day.

The pilot and crewmember were conducting a flight in preparation for an air display routine at an air show when the aircraft was seen by numerous witnesses to climb and enter cloud. A short time later, the aircraft was observed to exit cloud in a steep spiralling dive that continued until the aircraft struck the sea. Both occupants were killed on impact.

1. Factual information

1.1 History of the flight

- 1.1.1 On Friday 19 March 2004 at Warbirds headquarters, Ardmore aerodrome, the crewmember briefed the pilot for a flight that was planned to take place over the Firth of Thames and in addition, within the confines of special use airspace D220 (an area in the Waikato region that is extensively used for aerobatic flight).
- 1.1.2 The objective was to be a critique of the pilot's suitability to perform an air display in the Fougas at the Taupo Air show scheduled the next day, Saturday 20 March 2004. The crewmember telephoned Ardmore Unicom and activated Special Use Airspace D220 between 1015 and 1035 hours.
- 1.1.3 The pilot arranged for the aircraft to be refuelled to full tanks, including fuel in the wings tip-tanks, and then completed his pre-flight. After an uneventful start, the aircraft was taxied out to the active runway with the pilot seated in the "normal" forward crew seat position, and the crewmember seated behind him.
- 1.1.4 The pilot contacted Ardmore Unicom and called "lining up runway 21 seal" then "Fougas rolling runway 21 to vacate east from downwind". The aircraft was recorded airborne at 1002, and was observed to proceed toward the Firth of Thames.
- 1.1.5 Local residents and visitors in the Kaiarau Township near Thames witnessed the aircraft over the town and surrounding area. Of those interviewed, most described a series of high speed horizontal runs that included aileron rolls. At the end of each run, the aircraft was then observed to enter a climb followed shortly after by what appeared to be a steep turn or a roll and reversal of direction.
- 1.1.6 On the last high speed run, the aircraft was observed to climb and enter an overcast cloud base. Almost all of the witnesses recall that the aircraft exited the cloud cover in a steep nose down attitude, and "spiralled", as it descended toward the water. The aircraft did not recover and it plunged into the sea some 200 metres off the foreshore, north of the Kaiarau boat ramp.
- 1.1.7 Witnesses nearest the site declared that the engines continued to "run down" under the water for a short time. Several of these witnesses waded out to the aircraft wreckage but it was immediately apparent that nothing could be done to

save the two occupants. Rescue personnel responding to the accident then commenced a recovery operation.

- 1.1.8 The accident occurred in daylight, at approximately 1016 hours, in the Firth of Thames. Grid reference 260-S12-150522, latitude S 37° 06.51', longitude E 175° 18.15'.

1.2 Injuries to persons

<i>Injuries</i>	<i>Crew</i>	<i>Passengers</i>	<i>Other</i>
Fatal	1	1	0
Serious	0	0	0
Minor/None	0	0	

1.3 Damage to aircraft

- 1.3.1 The aircraft was destroyed.

1.4 Other damage

- 1.4.1 Nil.

1.5 Personnel information

Personnel on board the aircraft consisted of the pilot and crewmember

- 1.5.1 **Pilot** Male, aged 56 years
 Licence: Private Pilot Licence (Aeroplane)
 Aircraft ratings: Numerous, including PA 28, C 172, C 180, NAA T6 Harvard, Dutchess BE 76, DH 104 Dove, Fouga Magister CM 170, P40 Kittyhawk, Yak 52
 Aerobatic rating: valid until 18 November 2005
 Low level authorisation: valid until 20 January 2005
 Medical certificate: Class 2, valid until 13 April 2004
 Last proficiency check: BFR 18 November 2003
 Flying experience: 1780 hours, all types
 90 hours on type
 Total flying last 90 days: 27 hours all types, 48 minutes in the Fouga CM 170

Total flying last 30 days: 6 hours all types, 48 minutes in the Fouga CM 170

- 1.5.2 The pilot was issued a Private Pilot Licence on 11 July 1996 and predominantly flew a PA 28 which he owned. His pilot logbook records introduction to aerobatic flight between November 1996 and March 1997. No further aerobatics were performed by the pilot until 1998 when type ratings on a Trojan T28 and Harvard T6 aircraft were completed.
- 1.5.3 After completing the prerequisite basic gas turbine course, the pilot commenced type rating training on the Fouga Magister CM 170 in June 1999. He completed the type rating in November 1999, having flown 10.6 hours in the aircraft. He then continued to fly the aircraft on a regular basis until late 2001. During that period the pilot demonstrated competency in formation flying and was issued an aerobatic rating in accordance with CAR rule Part 61. The flying for the issue of the certificates was carried out in a T6 Harvard.
- 1.5.4 After 2001 the pilot flew the Fouga on a less frequent basis. In particular, between July 2002 and January 2003, no flying occurred for a six month period. A further gap of five months occurred up until the day before the accident when 48 minutes were flown, to carry out a test flight and satisfy the three takeoffs and landings recency requirement. The pilot had, on the evening after the test flight, declared that he had carried out low level aerobatics in the aircraft for the first time.
- 1.5.5 At the time of the accident, the pilot's total flying on the Fouga amounted to approximately 90 hours. His most recent low level authorisation, dated 20 January 2004, stipulated no aerobatics below 1500 feet and low level flypasts not below 200 feet.
- 1.5.6 The pilot's last routine medical assessment was completed satisfactorily on 13 April 2003. Limiting endorsements included a hypertension condition that required a resting ECG check and there was also a requirement to wear spectacles (distance vision) and have a spare readily available. The pilot was not known to be suffering any unreported medical condition and was observed to be in good spirits prior to the accident flight.

1.5.7	Crewmember	Male aged 57 years
	Licence:	Private Pilot Licence (aeroplane)
	Aircraft ratings:	Numerous, including military- BAC 167 Strikemaster, A4 Skyhawk, AA1, AA5, C336, V35B C 172, PA 28/30/38/39, J5 Auster, NAA T6 Harvard,
	Instructor rating:	“D” category
	Aerobatic rating:	last renewed 10 November 2002
	Low level authorisation:	valid until 20 January 2005
	Medical certificate:	Class 2, valid until 4 July 2004
	Last proficiency check:	BFR 14 July 2003
	Flying experience:	1836 hours
	Total flying last 90 days:	4 hours NAA T6 Harvard
	Total flying last 30 days:	1 hour NAA T6 Harvard

1.5.8 The crewmember commenced his flying career in the military and continued to fly when he left the RNZAF using a Commercial Pilot Licence and a “D” category instructor rating up until 1980. After an absence from flying, he renewed a Private Pilot Licence in February 1999, and up until the time of the accident he had been flying the North American T6 Harvard almost exclusively.

1.5.9 The flight on the day of the accident was the first time the crewmember had flown in the aircraft. He was not type rated, but held his own copy of the Fouga Flight Manual and handling notes. It was considered that his background and general expertise from flying aircraft such as the Strikemaster would be invaluable for any input required on the specifics of air display flying in the Fouga.

1.5.10 The crewmember’s last routine medical assessment was completed satisfactorily on 5 July 2003. Limiting endorsements on the licence were for trifocal spectacles to be worn and that regular lipid monitoring be carried out every two years. The crewmember was said to be in good spirits prior to the accident flight.

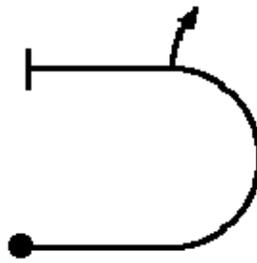
1.6 Aircraft information

1.6.1 Potez Air Fouga Magister CM 170, serial number 216, was constructed in France during 1960. The aircraft was a mid series build with original engines and entered service with the Armee de l’Air, and was active until June 1995, accumulating 2370 hours. It was last in service with the 8th Escadre de Chasse (8th fighter squadron) at the Centre de Tir et de bombardement until export to the United States of America.

- 1.6.2 The aircraft was imported into New Zealand in October 1997, where it was reassembled and registered ZK-FGA on March 17 1998. The aircraft was issued a Special Category Airworthiness Certificate by the CAA on 5 July 1998. Restrictions listed on the certificate were a 0.80 Mach number limit and an altitude restriction for flight not above 30000 feet.
- 1.6.3 The production Fouga Magister aircraft was of all metal semi-monocoque construction. Designed as a purpose built trainer, the aircraft was considered very stable and easy to fly. A distinctive V tail (“butterfly”) characterised the aircraft and combined the functions of both rudder and elevators. The mid mounted wings had wing tip fuel tanks; servo assisted ailerons and single-slotted flaps as well as perforated airbrakes that extended above and below the wings. The cockpit was a pressurised two place tandem seat arrangement.
- 1.6.4 The aircraft’s total time in service recorded in the maintenance logbook up to 18 March 2004 was 2553 hours. The last 100 hour inspection was completed during January 2004 at which time an Annual Review of Airworthiness was also performed. The aircraft then remained in the hangar awaiting return of overhauled components and spares that were required for the additional work done during the check. The aircraft was test flown on the day before the accident, no defects ensued and a release to service was issued.
- 1.6.5 The power plants were two Turbomeca Marbore II F3 turbojets rated at 882 lb static thrust each. The engines were mounted in close proximity to the aircraft centreline; therefore no discernable yaw was encountered during single engine operation. Low stall speeds and the low power of the engines was said to have contributed to the safety of the aircraft when in the hands of trainees. However, research done in France and Germany found the engines too underpowered for some aerobatic flight regimes, and there was also a tendency for the engine/s to flame out under certain circumstances. As a consequence, later variants built after ZK-FGA, were fitted with higher powered engines.
- 1.6.6 The left engine, serial number 6126, had accrued 1136 hours since overhaul. The last recorded maintenance on the engine occurred during a 100 hour inspection during January 2004 where the engine was removed in order to replace an oil filter seal. In addition, both left and right lower igniters were removed and overhauled.
- 1.6.7 The right engine, serial number 5349, had accrued 1160 hours since overhaul. The last recorded maintenance on the engine was a 100 hour inspection during January 2004.
- 1.6.8 The Fouga CM 170 Flight Manual provides essential information regarding limitations and the flying characteristics of the aircraft. With respect to aerobatics, all manoeuvres are permitted except inverted flight for longer than one minute and 20 seconds, snap rolls, and forward loops. These limitations are applicable with or without the installation of tip-tanks, either full or empty. However, past operators of Fouga aircraft understood that no military aerobatics were flown unless the tip-tanks were empty.

- 1.6.9 The stall speed of the Fouga, with landing gear up, no flap, and no speed brakes deployed, is specified in the Flight Manual as 87 knots. Buffeting occurs at 90 knots, and during the stall, elevator control remains positive and no uncontrollable rolling tendencies occur. In a turn, the stall is often characterised by a sudden roll and recovery can be as simple as relaxing “stick” pressure and rolling the wings level.
- 1.6.10 The Flight Manual specifies the minimum altitude for spins as 17000 feet agl or above, and with tip-tanks empty. When a spin is fully developed, the altitude loss is approximately 1000–1200 feet per turn. Intentional inverted spins are prohibited, but may be entered unintentionally by excessive use of forward movement of the control column and extreme misuse of rudder, for example during the half roll of the Immelman³ (Fig 1) or after an incorrect recovery from a normal spin. The Flight Manual includes a caution, stipulating spins are to be recovered above 13000 feet agl.

Immelman



The figure starts with a half loop to inverted flight. A half roll then results in horizontal upright flight. This is one of the manoeuvres that have been used since WW I to reverse direction. This manoeuvre does not preserve speed and altitude. It trades speed for altitude.

Fig 1

- 1.6.11 Recovery from either a normal or inverted spin requires precise control inputs as provided by instructions contained within the Flight Manual, otherwise a spin may occur in the opposite direction. In addition, if there is doubt whether the spin is inverted or normal the turn needle of the turn and slip indicator should be observed before starting the recovery procedure.
- 1.6.12 With respect to weight and balance, the exact weight at the time of the accident could not be determined. However, in all cases of possible loadings (one or two pilots, tip-tanks full or empty), the aircraft remains within the approved centre of gravity positions stipulated in the Flight Manual.

³ [The Immelman Turn](http://www.furball.warbirdsiii.com/krod/ACM-immelman.html) - <http://www.furball.warbirdsiii.com/krod/ACM-immelman.html>

1.7 Meteorological information

- 1.7.1 On 19 March 2005 a narrow ridge covered the North Island, with a Southwesterly flow over central and northern parts of the North Island. Southwesterly winds of 10-15 knots were developing during the morning. A solid deck of stratocumulus cloud covered western and central areas of the North Island and gradually began to break up from late morning. The Auckland Radar showed isolated showers about the western side of the Coromandel Peninsular during the morning, but no stations in the area reported any precipitation around the time of the accident.
- 1.7.2 Observations from stations at Whenuapai, Auckland and Hamilton airports, and satellite pictures near the time of the accident, revealed the following likely cloud conditions:
Near the accident site at point S 37° 06.511 E175°18.14, a broken layer of stratocumulus (5 to 7 octas of cloud) was estimated with a cloud base at 4400 feet and cloud tops at 5000 feet.
- 1.7.3 During recovery of the wreckage, cloud cover was noted to be mostly overcast conditions with a cloud base estimated to be about 3500 feet. Witnesses to the accident considered the cloud existing at the time of the accident to be of similar height and cover. The day before the accident the cloud cover was reported to be significantly less in density.

1.8 Aids to navigation

- 1.8.1 Not applicable.

1.9 Communications

- 1.9.1 The pilot made two radio calls on Ardmore Unicom Traffic frequency 118.1 MHz. There were no other communications heard on any other frequency likely to be used during the flight. These frequencies included the MBZ 120.4 MHz, Coromandel Traffic frequency 119.1 MHz, Mercer Traffic frequency 133.05 MHz or the emergency frequency 121.5 MHz. The on duty Ardmore Unicom operator reported hearing “watch that cloud” and thought the transmission came from the Fouga, but this could not be confirmed on the tapes.

1.10 Aerodrome information

- 1.10.1 Not applicable.

1.11 Flight recorders

- 1.11.1 Not applicable.

1.12 Wreckage and impact information

- 1.12.1 The aircraft struck the sea approximately 200 meters off-shore during an outgoing tide. The wreckage path was aligned more or less on an easterly heading and all the wreckage was confined to a small area.

- 1.12.2 Damage was severe where the cockpit and forward fuselage section had entered the shallow water and continued on into a muddy sea-floor creating a substantial crater. Both wings had detached from impact forces and had “flown” on underwater for a short distance forward of the initial impact entry point. The centre/aft fuselage containing the engines, had followed on into the crater and had remained stuck-fast at an angle of approximately 45 degrees.
- 1.12.3 Prior to the commencement of the CAA field investigation, some of the wreckage had already been recovered to the shoreline by rescue personnel to prevent these items drifting away with the tide or local currents.
- 1.12.4 The main wreckage salvage and debris recovery from the sea-floor required several more days to accomplish. When the operation was concluded, an estimated 95 percent of the aircraft had been retrieved. The wreckage was then transported to a secure facility for detailed examination.

1.13 Medical and pathological information

- 1.13.1 Post-mortem examination showed that the pilot and crewmember died from injuries consistent with a high-energy impact.
- 1.13.2 There was no evidence of a pre-existing condition that could have resulted in incapacitation or affected the pilot’s ability to fly the aircraft.
- 1.13.3 Toxicological tests found nothing of significance.

1.14 Fire

- 1.14.1 Fire did not occur.

1.15 Survival aspects

- 1.15.1 Fouga Magister aircraft are not fitted with ejection seats. Escape from the aircraft is provided by unlocking the canopy/s and “bailing out” using an in-seat parachute.
- 1.15.2 Inspection of both canopy locking device geometries indicated they had remained in the locked position prior to, and during, the accident sequence.
- 1.15.3 The pilot and crewmember were wearing combined lap and shoulder harnesses, but the impact forces were unsurvivable.
- 1.15.4 The Fouga was fitted with an emergency locator transmitter however the unit incurred significant damage during the impact sequence and appears not to have operated. In spite of this, the unit did for some reason, trigger and operate normally subsequently.

1.16 Tests and research

- 1.16.1 Wreckage examinations were conducted at a storage facility. No damage was found to the forward fuselage and windshield that could be associated with pre-impact strikes with birds or other objects. The remaining fuselage, wings, and

tail section of the aircraft revealed no evidence of any pre-impact failures or malfunctions.

- 1.16.2 It was established that the left wing tip fuel tank entered the water first, and that the aircraft had been upright and rotating in an anti-clockwise direction at the time. Both wing tip fuel tanks were distorted in a manner that suggested that some fuel content had remained in them prior to impact.
- 1.16.3 Flight control components were identified and located to specific locations in the wreckage by using the aircraft's IPC as a guidance. Fracture surfaces and general damage found to the control mechanisms were typically impact related. As far as practically possible, integrity was determined to have existed throughout the flight control mechanisms prior to the accident. The likelihood of a control problem caused by the presence of FOD was likewise dismissed.
- 1.16.4 It was determined that the landing gear had remained in the up position, the speed brakes were stowed, and the flaps up; indicating that the aircraft was in a "clean" configuration prior to impact.
- 1.16.5 The engines were dismantled at a research facility and no evidence was found that would have indicated bird ingestion. However, seafloor mud and other debris were located in areas of the engines internal mechanisms, indicating that both engines were operating at the time of impact.
- 1.16.6 Aside from seawater contamination, there were no particulates found in the engines fuel strainers that may have hampered normal engine operations during the flight and it was concluded that there were no other mechanical problems found within the engines that would have prevented either from normal operation prior to impact.
- 1.16.7 Several cockpit instruments were removed from both crew stations and examined in a laboratory. Marks were found on both engine rpm indicators at a position that would indicate an idle power setting on the engines. Unfortunately, all the other instruments revealed they had been disturbed sufficiently enough during recovery of the wreckage, that no useful information could be gained.
- 1.16.8 A review of air traffic control primary radar return data (secondary radar returns were not detected), confirmed the track of the aircraft after take off as east towards Clevedon, then south via the Firth of Thames until about two and a half nautical miles south of Kaiiua Township. The returns then show a reversal in heading toward a northerly track, following that, a racetrack pattern is depicted around Kaiiua extending over a distance of approximately five nautical miles.
- 1.16.9 At 1015:41 a radar return plot of the Fouga abeam the township of Kaiiua recorded a ground speed of approximately 281 knots. At 1015:46 the plot is advanced further north but at a reduced ground speed of 267 knots. At this point the last two recorded radar returns are symbolised as "coasted". The coasted, or "ghost" signals are based on the last known primary radar return at 1015:46.

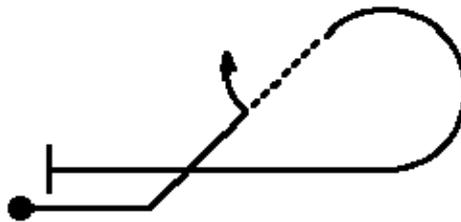
1.17 Organisational and management information

- 1.17.1 The Fouga was owned and normally operated in a private capacity. However, on the day of the accident, the flight was essentially in preparation for an upcoming air show; therefore the operation was required to be conducted under the provisions of Civil Aviation Rules, Part 91 *General Operating and Flight Rules*, and Part 149 *Aviation Recreation Organisations - Certification*. Both the pilot and crewmember were members of the New Zealand Warbirds Association [Inc].
- 1.17.2 The air show at Taupo would have been the first air display by the pilot in an ex military jet aircraft and the crewmember's primary role was to ensure that the pilot was capable of the task by keeping the aircraft clear of an imaginary spectator line while performing the manoeuvres specified in the briefing.
- 1.17.3 In keeping with the pilot's experience the sequences to be performed were limited to high speed horizontal runs, aileron rolls and wing-overs but were not to involve pitch manoeuvres. The briefing on how the flight was to proceed was depicted on a "whiteboard" as a general schematic. Unfortunately after the flight departed, the white-board was wiped clean to necessitate a briefing for another flight detail.
- 1.17.4 Procedures for the issue of a low level display authorisation are set out in The New Zealand Warbirds Association's Aviation Recreation Organisation Exposition. A prerequisite for a low level display certificate issue is that an assessment must be carried out by a qualified flight instructor who holds an A or B instructor rating. The crewmember was not type rated on the aircraft, nor was he a qualified A or B instructor. However, the Warbirds Association executives considered that his background and experience were well suited for the exercise.

1.18 Additional information

- 1.18.1 The day before the accident, the pilot conducted a test flight after the aircraft had undergone maintenance. The elapsed time for the flight amounted to 48 minutes and during this time the pilot completed three take offs and landings for recency purposes.
- 1.18.2 Part of the flight happened to be observed by a current RNZAF military jet pilot. The witness recounted that the aircraft was flying about the Firth of Thames and was conducting aerobatics including a manoeuvre referred to as a reverse half Cuban Eight⁴ (Fig 2).

Reverse Half Cuban Eight (illustrative purposes only)



*This figure starts with a pull to a 45 degree up-line. Centred on this line is a half roll from upright to inverted. Five-eighths of a loop completes the figure to horizontal flight.
This is one manoeuvre that can be used to reverse direction while preserving altitude and airspeed.*

Fig 2

- 1.18.3 The witness thought the pilot was a little low to be performing the manoeuvre because the pilot is required to “pull” toward the ground after rolling inverted in the climb, and this would call for careful height management.
- 1.18.4 The information on the low altitude was confirmed when radar return recordings for that flight were viewed and it was found the aircraft had been flown as low as approximately 100-200 feet at speeds greater than 300 knots around Great Barrier Island and the Firth of Thames area.
- 1.18.5 New Zealand Warbirds Association personnel involved in preparing for the Taupo Airshow were not aware that the pilot had conducted any aerobatic manoeuvres that day.

1.19 Useful or effective investigation techniques

- 1.19.1 Nil

⁴ [The R/C Aircraft Proving Grounds - 1/2 Reverse Cuban Eight Animation](http://www.geistware.com/rcmodeling/aerobatics/maneuvers/half_reverse_cuban_eight.htm)
http://www.geistware.com/rcmodeling/aerobatics/maneuvers/half_reverse_cuban_eight.htm

2. Analysis

- 2.1 It appears that the accident was initiated as a result of a departure from controlled flight after entering cloud. A question as to whether the aircraft was flown by the crewmember at the time was considered but found to be unlikely. He was not rated on the aircraft type, but was simply there to assess the flight and report to the CFI of Warbirds that the pilot had performed the flight as briefed.
- 2.2 While there was no accurate aircraft height information available to the investigation, it is unlikely the cloud base height fluctuated to any great extent. It is possible however, that the horizontal speed runs were flown at varying heights or that the pilot in command lost sufficient situational awareness during the last aerobatic sequence and flew the aircraft into cloud inadvertently as opposed to flying into cloud as a deliberate act.
- 2.3 ZK-FGA was fitted with the lower powered engines and the airspeed would have decayed significantly during the climb. Given the consistency of witnesses' recall, it is highly probable that once immersed in cloud the aircraft departed from controlled flight and entered a spin. The relatively low altitude of the aircraft at the time and retention of some of the fuel content in the tip-tanks then made recovery a most unlikely task.
- 2.4 Given the speed of events, it is unlikely that the crewmember would have been able to take over and effect a recovery, regardless of flying ability or qualifications.
- 2.4 Correlating all the witness statements, it would appear that the aerobatic sequences flown prior to the accident were similar to those observed by the RNZAF pilot the day before. However, why aerobatics that may have included manoeuvres involving pitch were flown, could not be established in this investigation.
- 2.5 The location of the accident exposed the general public of Kaiiua Township to unnecessary risk. The fact that aerobatic sequences were carried out the day before in the same area heightens concerns for public safety, particularly where the pilot performed these aerobatic manoeuvres had not flown the aircraft for five months and had not performed low level aerobatics on the aircraft type before.
- 2.6 In terms of compliance with Civil Aviation Rules, the pilot appears to have been in non-compliance with the following Rules on both the accident flight and test flight:
- 61.555 (3) Privileges and limitations – not authorised to operate below 1500 feet and perform of low level aerobatics.
 - 91.201 (2) (2) during the flight, ensure the safe operation of the aircraft and the safety of its occupants.
 - 91.237 (a) exceeded 250 knots below 10000 feet (not authorised by Warbirds to be at low level in the Firth of Thames area).
 - 91.311 (a) (1) violated minimum heights for VFR flight.

- 91.301 (a) (2) did not maintain the aircraft clear of cloud.
 - 91.701 (a) (1) performed aerobatics within a horizontal distance of 2000 feet of a town, or settlement.
 - 91.701(c)(2) (i) (ii) did not hold an aerobatic rating issued under Part 61 that authorised aerobatic flight to a specified height below 1500 feet; and performed aerobatic flight below the height authorised in his aerobatic certificate.
- 2.7 The pilot was in compliance in respect of recency requirements for maintaining a type rating. However, forty-eight minutes flying in a jet aircraft after a period of five months' absence is not considered suitable preparation for a pilot intent on performing a low level air display at an airshow. For a pilot to be considered competent performing display flying in jet aircraft requires a level of progression readily determined by those tasked with evaluating a pilot's suitability at that level.
- 2.8 At Sydney, Australia, in June 2004, a seminar specific to warbirds was arranged by CASA and targeted safety at air shows. One of the many issues raised was the difficulty experienced by some operators in maintaining currency in warbird aircraft. One of the problems discussed was aircraft downtime attributable to maintenance. These circumstances can directly affect a pilot's ability to remain current and is a situation similar to that of ZK-FGA where the aircraft remained parked in a hangar over a long period awaiting spares and did not become available until two days prior to the air show.
- 2.9 To date, human factor elements play an active part of causation in over 70 percent of occasions involving fatal air show accidents and display practices. In the United States the NTSB is concerned that increasing diversity in personal use aircraft, particularly the number of former military aircraft, some supersonic, is steadily growing. The NTSB is of the opinion that GA pilots transitioning to "warbirds" are often unprepared to meet the challenge of flying these aircraft that were designed to meet military standards.
- 2.10 Authorities in the United Kingdom share similar concerns, CAP 667 (Review of General Aviation Fatal Accidents 1985-1994) cites low flying/aerobatics as the third most frequent cause of accidents studied in the review. In two thirds of those accidents, loss of control and external pressures to take risks were the predominant causal factors. The review concluded that the system failed to prevent enthusiastic untrained PPL holders from performing aerobatics, and recommended an aerobatic certificate along the lines of the AOPA Aerobatic certificate
- 2.11 During the 1990's, the United States air show industry was required to develop an effective safety strategy owing to the unprecedented number of fatalities occurring at air shows. What resulted is the Aerobatic Competency Evaluation (ACE) programme administered by ICAS. The programme's main objectives are to establish industry standards and provide the entire air show industry with a tool for periodically evaluating the competency of air show pilots, necessary

experience levels, the certification process, peer review, and all other points necessary to implement a standards and evaluation programme.

3. Conclusions

- 3.1 The pilot was appropriately licensed, rated, and medically fit for the task.
- 3.2 The aircraft was airworthy and operating normally until the accident.
- 3.3 The pilot breached numerous Civil Aviation Rules.
- 3.4 Retention of the briefing details may have assisted the investigation.
- 3.5 By assigning a crewmember without the prerequisite qualifications, The New Zealand Warbirds Association [Inc] was in non-conformance with its exposition.
- 3.6 The pilot had little or no experience performing aerobatic manoeuvres at low level in jet aircraft.
- 3.7 The aerobatic manoeuvres were performed about an area that had the potential to impact on public safety.
- 3.8 The aerobatic manoeuvres performed by the pilot were not authorised by the New Zealand Warbirds Association [Inc].
- 3.9 During an aerobatic manoeuvre the aircraft was inadvertently flown into cloud.
- 3.10 The aircraft's exit from cloud was an erect spin that was probably not recoverable under the circumstances.
- 3.11 The impact was unsurvivable.

4. Safety recommendations

- 4.1 A recommendation was made to, and accepted by, the executive of the New Zealand Warbirds Association [Inc] that they strengthen their exposition to reflect greater control and influence over private owner/operators of warbirds aircraft when private owners and operators intend to include their aircraft in air display activity.

5. Safety actions

- 5.1 The CAA will review Advisory Circular 91-1 to include recency requirements and guidelines for aerobatic flight, particularly in areas applicable to the type of activity and the type of aircraft in which the activity is to be performed. Civil Aviation Rule Part 149 will be reviewed to reflect flight recency requirements.
- 5.2 New Zealand Warbirds Association [Inc] will review Advisory Circular 61-1.12 in conjunction with Advisory Circular 61-1.3, Appendix 3 sub topics 10.44 to 10.54, with the intent that they make provision for this area of human factors in their exposition.
- 5.3 The Royal New Zealand Air Force recently initiated a display flying training program for the benefit of military and civilian pilots. The training is conducted over a weekend and will continue on an annual basis.

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