



Report 96-001

Vickers Armstrong Supermarine Spitfire Mark XIV

ZK-XIV

Wanaka Aerodrome

2 January 1996

Abstract

At about 1200 hours on Tuesday 2 January 1996 the pilot commenced a take-off on vector 29 at Wanaka Aerodrome, in Mark 14 Spitfire ZK-XIV. During the take-off the aircraft swung to the right, diverged from the grass vector, and became airborne but the tail caught the aerodrome boundary fence. The aircraft rolled to the right and struck the ground inverted. The pilot was seriously injured in the accident.

Transport Accident Investigation Commission

Aircraft Accident Report 96-001

Aircraft type, serial number and registration:	Vickers Armstrong Supermarine Spitfire Mark XIV 6S 648269, ZK-XIV
Number and type of engines:	1 Rolls-Royce Griffon 74
Year of manufacture:	1945
Date and time	2 January 1996, 1200 hours ¹
Location:	Wanaka Aerodrome Latitude: 44° 43'S Longitude: 169° 15'E
Type of flight:	Private
Persons on board:	Crew: 1
Injuries:	Crew: 1 serious
Nature of damage:	Substantial
Pilot in Command's Licence:	Private Pilot Licence (Aeroplane) Commercial Pilot Licence (Helicopter)
Pilot in Command's age:	57
Pilot in Command's total flying experience:	More than 12000 hours Approximately 200 hours on Spitfires 5.5 hours on the Mark 14 type
Investigator in Charge:	D G Graham

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

1. Factual Information

- 1.1 At approximately 1200 hours on Tuesday, 2 January 1996, the pilot commenced a take-off in Mark 14 Spitfire ZK-XIV on vector 29 at Wanaka Aerodrome.
- 1.2 During the take-off the aircraft diverged significantly to the right. It became airborne but the tail caught the aerodrome boundary fence. Shortly afterwards the aircraft rolled to the right, descended, then slid inverted along the ground. No fire occurred.
- 1.3 The pilot received serious head injuries in the accident.
- 1.4 In preparation for a forthcoming flying display the pilot had arranged to combine some general handling with later practice for a formation "fly-by" involving ZK-XIV and a P-51 Mustang. Both aircraft were based at Wanaka Aerodrome and prior to flight were parked on the grass near the Alpine Fighter Collection hangar.
- 1.5 At about 1145 hours, after completing an external walk-around inspection and routine pre-flight checks the pilot climbed into the cockpit of ZK-XIV and started its engine.
- 1.6 While still parked, during engine warm-up, an RTF ground test indicated that the KX125 VHF nav/com transceiver installed in ZK-XIV was not functioning. The pilot shut down the engine to investigate. The VHF unit was found to be protruding from its rack and a short delay was incurred while the appropriate Allen key was obtained so that the unit could be re-positioned in the rack and locked in place.
- 1.7 Meanwhile the P-51 had started, and taxied to the eastern end of the aerodrome. A light westerly drift of some two to three knots favoured the use of runway 29 for take-off. The pilot re-started ZK-XIV and taxied to join the waiting aircraft.
- 1.8 The P-51 moved onto the threshold of runway 29 and the pilot positioned ZK-XIV at the commencement of grass vector 29 on the northern side of the sealed runway. A RTF ground test at this time confirmed that the aircraft's VHF transceiver was operating satisfactorily. The pilot indicated reception was "strength 5".
- 1.9 Witnesses beside the southern fenceline about halfway along the runway watched the P-51 take-off and climb to the west. An estimated one to two minutes later the pilot of ZK-XIV began his take-off.
- 1.10 The aircraft initially tracked straight on the grass vector then began to veer to the right, the main wheels and tailwheel still on the ground. It continued in a curve to the right and the left wing lifted. The aircraft was heading toward the north and became airborne, "rising sharply", as if the pilot tried to clear the boundary fence. The aircraft reached an estimated height of about "10 metres" before rolling 90° to the right and striking the ground. The engine sound remained constant throughout the take-off.
- 1.11 A number of operational personnel at the aerodrome, as well as staff associated with the New Zealand Fighter Pilots Museum, observed the accident or were alerted to its occurrence immediately. Several drove directly to the site to render assistance to the pilot. Local medical and emergency services were contacted and arrived on the scene within ten minutes of the accident.

- 1.12 The aircraft had come to rest inverted, trapping the pilot in the demolished cockpit. He was retained securely in his seat by the four point harness. The right wing had broken off at the wing root, and rescuers were able to lift the left wing and roll the fuselage onto its right side to extricate the pilot and move him a safe distance from the aircraft.
- 1.13 A considerable quantity of fuel had been released from the ruptured fuselage tanks forward of the cockpit, and fire extinguishers brought by those first on the scene were used to douse the engine and surrounding area to minimise the risk of fire. Additional fire extinguishers were employed pending the arrival of the New Zealand Fire Service.
- 1.14 The pilot was wearing a World War II type flying helmet with fitted earphones. This had afforded little protection for his face and head in the inverted impact and resulting canopy and windscreen collapse.
- 1.15 Following medical attention on-site, the seriously injured and unconscious pilot was flown from Wanaka Aerodrome to Dunedin Hospital.
- 1.16 The aerodrome's northern boundary was defined by a fenceline parallel to runway 11/29, at a distance of 140 m from the runway's northern edge.
- 1.17 At the time of the accident vector 29 comprised a mown strip, 28 m wide, on the northern side of the runway. The surface was firm and dry and the grass was short. The remainder of the grassed area between the runway and the boundary fence was unmown with relatively sparse tall grass, 300 mm to 400 mm high, adjacent to vector 29 but dense lush growth nearer the fenceline.
- 1.18 The boundary fence was of standard post and wire construction. Round fenceposts, 1.2 m high and approximately 140 mm in diameter, were positioned about 11 m apart, with two one metre high "waratahs" equally spaced in between, supporting an upper strand of barbed wire and 600 mm high square mesh wire netting at the lower level. Electrical power outlets, for display purposes, were mounted on every third fence post in the area struck by the aircraft.
- 1.19 Wheel marks showed that after commencing the take-off adjacent to the threshold of runway 29, ZK-XIV had tracked essentially straight, following the centre line of the grass vector. About 150 m into the take-off run, the aircraft had begun to track in a curve to the right. The wheelmarks indicated that ZK-XIV had entered the long grass on the northern side of the vector 285 m from the beginning of the take-off, angled 15° to the right.
- 1.20 The wheelmarks continued in an arc to the right through the denser growth and led to an 11 m wide gap where the boundary fence had been destroyed, at an equivalent distance from the take-off point of 480 m. The wheelmarks showed that the aircraft had diverged 45° from the vector centre line by this stage, and had become airborne just before reaching the fenceline.
- 1.21 A broken power outlet unit lay on the ground in the fence line gap but the substantial post on which it had been fixed had fallen in the next paddock 52 m to the north-west. The dislodged fence post was still attached to a length of wire mesh which had been pulled away from the fenceline for about 35 m. A considerable length of twisted and broken wire mesh lay beyond the fencepost stretched in the direction of the aircraft's brief flight.
- 1.22 Distinctive score marks showed that the right wing of ZK-XIV had contacted the ground about 115 m beyond the boundary fence, with the aircraft on a heading of approximately 355° M. Broken propeller blades, 15 m further on, commenced a trail of wreckage which included a canopy frame and perspex fragments alongside a gouge 6 m long, 500 mm deep, confirming the aircraft's inverted attitude as the engine and fuselage struck the ground.

- 1.23 Scattered components and further surface scoring, were consistent with a continued groundslide of some 40 m, during which the aircraft broke through another post and wire fence. Various strands of wire from this fenceline remained entangled in the fuselage structure and the separated right wing. However, remnants of wire mesh around the tail wheel assembly and a significant gash in the undersurface of the right tailplane confirmed that ZK-XIV had snagged the aerodrome boundary fence during the take-off.
- 1.24 The aircraft came to rest 170 m beyond the aerodrome boundary fence.
- 1.25 Relevant information obtained from the on-site examination included the following:
- The undercarriage selector was in the “DOWN” position. The main undercarriage, and tailwheel, were down and locked at the time of the accident.
 - The brakes were ‘off’.
 - No abnormality was observed in relation to the condition or operation of the main wheels and tailwheel, or their respective tyres.
 - The aircraft’s wing flaps were up.
 - Failures in the aileron control circuit were consistent with overload due to impact forces.
 - The pilot’s seat structure was intact, with the seat in a raised position. The canopy had been closed.
 - The pilot’s harness inertia reel operated satisfactorily. The harness lock was in the locked position.
 - Disruption to the cockpit on impact had dislodged and distorted the VHF transceiver rack.
 - The transceiver unit had been ejected from the rack during the aircraft’s ground slide.
 - The locking tang on the transceiver unit was in the locked position.
 - The elevator was trimmed slightly nose down from neutral.
- 1.26 The upper half of the aircraft’s rudder had been torn off and the rudder trim tab was completely detached from the rudder assembly. The vertical fin had been shorn off close to the fuselage. These items were recovered in the wreckage trail. Their individual locations were consistent with progressive disruption to the fin and rudder assembly of the inverted aircraft on impact and during the groundslide. Structural damage and fractures were consistent with impact forces.
- 1.27 The rudder trim actuator was mounted internally in the vertical fin. The aft trim chain and sprocket assembly had broken away from the actuator when the vertical fin separated from the aircraft. The trim chain and cables, operated by the rudder trim handwheel in the cockpit, were intact and all connections were secure. The trim chain, as found, was in a position close to neutral.

- 1.28 The rudder trim tab on ZK-XIV was constructed from aluminium alloy sheet, welded to form an integral unit, with half the tab permanently offset by approximately 13°.
- 1.29 The rudder trim actuator was removed from the fin and comparative measurements and calculations made to determine the equivalent tab deflection. The linear position of the actuator, as found, was 2.54 mm (0.100 inches) away from neutral towards left rudder trim. This equated to a tab deflection of slightly under 2° (towards) left rudder trim from neutral, with the rudder centralised.
- 1.30 It was established that full travel of the rudder trim handwheel deflected the anti-balance tab 14° left or right.
- 1.31 ZK-XIV had been imported to New Zealand in 1994. The aircraft had been fully restored and overhauled to airworthy status in the United Kingdom during preceding years. The original airframe flying hours were not known but due to the complete rebuild which had taken place, operating hours reverted to zero at the time of United Kingdom registration. Ten and a half hours had been flown in the United Kingdom, and 35.1 hours in New Zealand up to the occurrence of the accident.
- 1.32 ZK-XIV was maintained in accordance with Approved Maintenance Schedule NZCAR F6 Appendix 1. The most recent inspection had been carried out on 4 May 1995. Maintenance Release Number 0285779 had been issued following this inspection, valid until 4 May 1996 or the attainment of 130.8 hours total time in service. The aircraft had last flown on 12 November 1995. No defects or malfunctions with respect to the engine or airframe, or problems relating to directional control, had been reported prior to the accident flight.
- 1.33 The pilot was accustomed to flying the Merlin-engined Mark 16 Spitfire type. His introduction to the Griffon-engined variant was in November 1994 when he first flew ZK-XIV. Although injury from an earlier accident limited the pilot's ability to apply left rudder directly, he had flown the aircraft without difficulty. He had made seven flights and accumulated a total of 5.5 hours on the Mark 14 type, all in ZK-XIV. His most recent experience on the type was a flight in ZK-XIV on 4 May 1995.
- 1.34 During the eight months since that flight the pilot had made more than 20 flights in the Mark 16, for a total of 17.3 hours.
- 1.35 Within the nine days preceding the accident he had carried out three flights in the Mark 16, totalling 2.55 hours. The most recent flight was on 29 December 1995.
- 1.36 The maximum power of the Griffon-engined Mark 14, ZK-XIV, was substantially greater than that of the Packard Merlin Mark 16 which the pilot flew regularly. In addition the direction of propeller rotation on the Mark 14 was opposite to that on the Mark 16. The propeller had five blades, compared with three blades on the Mark 16.
- 1.37 The handling characteristics of the Mark 16 Spitfire were such that although the Pilot's Notes included "rudder trim - fully to starboard", as part of the pre-take-off checks, the effect of rudder trim and its significance in directional control on take-off was less marked than in the more powerful Mark 14 type aircraft.
- 1.38 Individual aircraft varied in terms of handling. Pilot reports suggested that rudder trim could be left in an essentially neutral position in the Mark 16 aircraft customarily flown by the pilot, without compromising directional control during take-off.

1.39 Prior to importation to New Zealand, ZK-XIV had been test flown. The United Kingdom Test Flight Report contained the following notes: (reproduced in part only)

Directional control - smooth and precise. Normal Spitfire. Usual care required to guard against rapid swings or nose-over.

Take-off - Flap position "UP"
Trim position elevator "+1/2"
rudder "full Left"
Power setting used "Progressively increasing to +8/2700 rpm"

Comment - Directional control in crosswind. Forces after take-off etc.

This is a normal Griffon-engined Spitfire. Ample directional control if power increased at appropriate rate. Take-offs made with no difficulty with crosswinds up to 17 knots. Aircraft accelerates rapidly after take-off requiring forward trim (to about -1) and about one turn of rudder trim to the right (to back off from fully left).

1.40 Relevant extracts from Pilot's Notes Spitfire MK XIV included:

Part I - Introduction:

This aircraft embodies Mod. No. 1672 having a large chord rudder with "anti-balance" trimmer tab to improve directional stability and control.

Trimming tabs controls

The elevator trimming tabs are controlled by a handwheel on the port side of the cockpit and their setting is shown on an indicator on the bottom left-hand side of the instrument panel.

A smaller handwheel aft of the elevator trimming tab control operates the rudder trimming tab. No indicator is provided but clockwise rotation of the control tends to yaw the aircraft to starboard.

Part II - Handling

Check list before take-off

T - Trimming tabs

Rudder: Fully left (handwheel fully back)

Elevator: a) At typical service load, but no fuel in the rear fuselage tank, 8,376 lb.: Neutral ...

Take-off

For a normal take-off, open the throttle slowly up to about +7 lb./sq. in. only. **There is a strong tendency to swing to the right** and to crab in the initial stages, and if much power is used tyre wear is severe. Power should be increased, consistent with rudder control, to +12 lb./sq. in. boost on becoming airborne.

The aircraft should be flown off at a speed of approximately 90 knots

After raising the undercarriage as speed increases, directional retrimming will be necessary

General flying

Controls - The elevator, rudder and their trimming tabs are powerful and sensitive and should be used with care. The elevator remains light throughout the speed range but the rudder and ailerons become heavier as speed increases.

Change of trim

Changes of power and of speed induce marked changes in directional trim. These should be counteracted by careful and accurate use of the rudder trimming tab.

Approach and landing

.... (iii) On those aircraft which have large chord rudders it is recommended that the rudder trimming tab control should be set approximately to neutral on the final straight approach in order to reduce the heavy footload necessary if the landing is baulked.

.... Mislanding

(i) The aircraft will climb away easily with the undercarriage and flaps down and the use of full take-off power is unnecessary.

(ii) Open the throttle steadily to give the desired boost.

Note. - The torque effect of the Griffon engine is opposite to and more powerful than that of the Merlin engine, and is of opposite sign.

(iii)

(iv)

(v)

(vi) On aircraft which have large chord rudders the footload necessary in the event of a mislanding will be very great if the rudder trimming tab is not pre-set during the final approach (see Note (iii), reproduced above)

- 1.41 A witness positioned near the threshold of runway 29 recorded on video ZK-XIV lined up prior to take-off, the take-off run, and the subsequent brief flight and ground impact. Although events were recorded from a distance, the video record supported the description of the accident sequence provided by other observers. It also confirmed that the pilot completed engine run-up checks after the P51 had departed, and moved the cockpit canopy towards the closed position before commencing take-off. Engine sound suggested normal operation, consistent with the application of medium power. No distinctive variation of power occurred during the take-off.
- 1.42 The aircraft's initially gradual but increasing divergence from vector 29 was evident, confirming the track established from the wheel marks. Following nose pitch-up, immediately prior to the aerodrome boundary fence, or induced by contact with it, the airborne aircraft rolled to the right in a continuous motion and struck the ground inverted.
- 1.43 The pre take-off setting of the rudder anti-balance tab could not be established conclusively from the video record. However the left side view of the aircraft on line-up and its appearance during the take-off sequence suggested the tab was in the neutral position rather than fully deflected.

2. Analysis

- 2.1 No mechanical defect or abnormality was evident which might have accounted for ZK-XIV diverging to the right during take-off. The light westerly drift, while favouring vector 29 for a take-off on the grass, involved no appreciable cross-wind. The surface of the grass vector was mown, firm and dry overall, without soft areas or patches of longer growth which might have initiated an unexpected swing to the right.
- 2.2 Witness reports, and the video record, indicated that ZK-XIV was aligned correctly at the commencement of the take-off, and an appropriate level of power was applied. The aircraft's swing to the right as the take-off progressed, lifting of the left wing, and continued divergence to a heading 45° from the intended take-off path was consistent with a torque induced loss of directional control.
- 2.3 The video record, and ground evidence, indicated that although the aircraft became airborne, entanglement of the tail wheel assembly in the wire mesh fencing at the aerodrome boundary, and consequent retardation resulted in an uncontrollable roll to the right and an immediate descent.
- 2.4 Investigation suggested that the take-off was made with the rudder trim positioned slightly left of neutral. The Pilots Notes for the Mark 14 Spitfire type indicated that the rudder trim should be set fully left (handwheel fully back) prior to take-off.
- 2.5 The pilot was experienced in operating Spitfires, and had flown ZK-XIV without difficulty on previous occasions. Eight months had elapsed, however, since he had last flown this aircraft. Most of his flights in the last eight months were carried out in the Mark 16 type. His most recent Spitfire flying, three days prior to the accident, was in the Mark 16.
- 2.6 During take-off the Mark 16 was likely to swing to the left, requiring right rudder to keep straight. The more powerful Mark 14 was noted, however, for its strong tendency to swing to the right. Considerable left rudder force was required to counter any incipient swing.
- 2.7 Although ZK-XIV incorporated the large chord rudder trim tab, introduced to improve directional control characteristics, pilots familiar with the aircraft type regarded it as essential that the rudder trim be set fully left to minimise the rudder control forces during take-off, and reduce the risk of losing control on the ground.
- 2.8 ZK-XIV, and the Mark 16 Spitfire flown regularly by the pilot, while differing markedly in engine and propeller installation, were similar in cockpit and systems layout. The rudder trim handwheel was mounted in the same position and operated in a similar manner in both aircraft. The possibility could not be discounted that the pilot, during his pre-take-off checks, not having flown ZK-XIV for some time, and having recently operated the Mark 16, may have inadvertently set the rudder trim to a position more suitable for the latter aircraft.
- 2.9 The delay occasioned by the necessity to investigate the radio problem and re-secure the VHF transceiver unit in ZK-XIV before taxiing, and the prior departure of the P-51, introduced potential for elements of distraction and time constraint with regard to the flight. The available evidence however indicated that the pilot completed engine run-up and pre-take-off checks in a disciplined and unhurried manner before commencing the take-off.
- 2.10 The pilot was regaining familiarity on the Mark 14 Spitfire type. However, his previous experience would have alerted him to the aircraft's tendency to swing to the right on take-off and the necessity for any incipient swing to be corrected immediately.

- 2.11 The pilot had no detailed recollection of events surrounding the accident. Whether factors additional to the rudder trim setting were involved could not be established.
- 2.12 Once effective directional control was lost the pilot was faced with the alternative of abandoning the take-off, with the probability, in this case, of colliding with the aerodrome boundary fence, or continuing the take-off and attempting to become airborne early enough to clear the fence. The accident circumstances suggested that the pilot chose the latter option.
- 2.13 Accidents resulting from an uncontrolled swing on take-off occurred periodically in World War II, during the operation of high powered propeller driven fighters of tailwheel design such as the Griffon-engined Spitfire. The accident to ZK-XIV bore a close similarity to war-time experience.

3. Findings

- 3.1 The pilot was appropriately licensed for the flight.
- 3.2 ZK-XIV had a valid C of A and Maintenance Release.
- 3.3 The predominance of the pilot's considerable experience of Spitfires on the Mark 16 type with its milder left swing on take-off may have influenced his preparation for the take-off in the Mark 14 particularly as most of the pilot's Spitfire experience, and his recent flying, was on the Mark 16.
- 3.4 The pilot positioned and aligned ZK-XIV correctly for take-off on grass vector 29 and applied an appropriate level of take-off power.
- 3.5 The pilot did not correct the swing to the right which the aircraft developed during take-off.
- 3.6 Although the aircraft became airborne the engine torque and the retarding effect of the tail wheel assembly and right tailplane snagging a fence resulted in an uncontrollable right roll and inverted ground impact.
- 3.9 A modern protective safety helmet would have reduced the pilot's vulnerability to head and facial injury.
- 3.10 A pre take-off rudder trim setting slightly left of neutral instead of 'fully left' would have had the effect of requiring significantly increased force to counter the aircraft's characteristically powerful swing to the right.
- 3.11 The limitation of the pilot's ability to apply left rudder as a result of a pre-existing disability was not considered to be a significant factor in this accident.
- 3.12 Inadvertent mis-selection of less than 'fully left' rudder trim, prior to take-off, was the probable predominant factor in the accident.

23 October 1996

M F Dunphy
Chief Commissioner