No. 96-009

Piper PA32R-300 Lance

ZK-FMO

North Shore Aerodrome

18 February 1996

Abstract

On Sunday 18 February 1996 at 1430 hours ZK-FMO, a Piper PA32R-300 Lance, force-landed along a road shortly after take-off on runway 03 at North Shore Aerodrome. One passenger received serious injuries, and the pilot and three other passengers received minor injuries. The cause of the accident was the pilot's attempt to take-off with insufficient runway length available, for the prevailing conditions and the weight of the aircraft.

Transport Accident Investigation Commission

Aircraft Accident Report No. 96-009

Aircraft type, serial number and registration:	Piper PA32R-300 Lance, 32R-7780023, ZK-FMO
Number and type of engines:	One Lycoming IO-540-K1G5D
Year of manufacture:	1976
Date and time:	18 February 1996, 1430 hours*
Location:	½ nm north-east of North Shore Aerodrome Latitude: 36° 39.2′ S Longitude: 174° 39.7′ E
Type of flight:	Air Transport, charter
Persons on board:	Crew: 1 Passengers: 4
Injuries:	Crew: 1 Minor Passengers: 1 Serious 3 Minor
Nature of damage:	Aircraft destroyed
Pilot-in-Command's Licence:	Commercial Pilot Licence, (Aeroplane)
Pilot-in-Command's age:	33
Pilot-in-Command's total flying experience:	354 hours 13 hours on type
Information sources:	Transport Accident Investigation Commission field investigation.
Investigator in Charge:	Mr K A Mathews

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

1. Factual Information

1.1 At about 1330 hours on Sunday 18 February 1996 ZK-FMO, a Piper PA32R-300 operated by North Island Air Services Ltd, trading as Northern Air, departed from Auckland International Airport for North Shore Aerodrome. On board was the pilot, who had been chartered to fly four people from North Shore to Great Barrier Island for a fishing expedition.

1.2 The pilot advised that the aircraft had a total of 40 US gallons of fuel (240 pounds, 109 kg) on board when it departed, but a load sheet prepared by the pilot recorded a fuel weight of 300 pounds (136 kg). The flight took about 18 minutes to complete, after some eight minutes of taxiing and ground running.

1.3 After landing the pilot taxied toward the local Aero Club's clubhouse and parked the aircraft on the apron some 20 m to 40 m from the Aero Club's departure lounge. The passengers had been waiting at the aerodrome for the pilot to arrive and drove up to the aircraft after it had stopped. The pilot said he laid the passengers' cargo out beside the aircraft for loading, and was somewhat surprised by its quantity. He did not weigh the cargo, but said he estimated it to be "80 kg to 100 kg" in total weight.

1.4 After the pilot commenced loading the aircraft, he was asked by an Aero Club staff member to telephone the aerodrome's operator, who believed permission had not been given to the pilot to fly into and out of the aerodrome. The pilot explained to the operator that he had received such permission from the local Aero Club, several weeks before the flight. Further discussion resulted over the misunderstanding, and the pilot said he was told to take his passengers but not to return. As a result the pilot said he felt unwelcome at the Aero Club. After the accident the company Operations Manager received confirmation from the Aero Club CFI that approval had been given to conduct the flight.

1.5 The pilot completed the loading of the aircraft, and placed all of the cargo into the aircraft's aft baggage compartment, and onto the two rear seats and floor area in front of the seats. A number of fishing rods were positioned down the left side of the cabin, on top of the other cargo. Although a baggage compartment was available in the nose of the aircraft for 100 pounds (45 kg) of cargo, the pilot did not load any of the cargo into it.

1.6 The pilot completed a load sheet for the flight and entered each passenger's weight as 170 pounds (77 kg), and the total cargo weight as 280 pounds (127 kg). He entered his own weight as 170 pounds (77 kg) and the fuel weight as 300 pounds (136 kg). No fuel was uplifted by the pilot at North Shore. This gave a total load sheet take-off weight of 3560 pounds (1615 kg). The aircraft's maximum permitted take-off weight was 3600 pounds (1633 kg).

1.7 The pilot advised that he had checked the "P" charts and determined there was sufficient runway length available, and the centre of gravity to be "OK". Runway 03 at North Shore Aerodrome, the longest runway, however had a Group Rating Number[1] of 6 for take-off, and ZK-FMO had a Performance Group Rating[1] of 8 at 1633 kg.

1.8 Three of the passengers were seated in the aircraft's second row of seats, and the other passenger was seated in the front right seat, next to the pilot.

[1] Used to establish performance compliance for aeroplanes with a MCTOW of 2270 kg (5005 pounds) or less. The runway group rating number represents the highest of the groups authorized, eg: where group 6 is specified it includes all aeroplane groups from 1 to 6.

1.9 The pilot taxied the aircraft for runway 03 shortly before 1430 hours. He said he completed his normal pre take-off checks, selected "10° of flap", and ran the power up to "75% or 80%" at the threshold with the brakes applied. He checked that the temperatures and pressures were normal, released the brakes, applied "full power" and checked he had normal engine rpm and manifold pressure.

1.10 The aircraft accelerated along the runway and the pilot said he raised the aircraft's nose at 50 KIAS (knots indicated airspeed), and attempted to lift-off at 65 KIAS. According to ground witnesses, the aircraft had used most of the runway length before it became airborne and climbed "only about 20 feet". After the aircraft lifted off the pilot said he raised the undercarriage but the aircraft did not seem to climb. Several seconds later he realised he was probably not going to clear the trees and houses off the end of the runway and raised the nose further, but the stall warning horn sounded. At this point he made a shallow right hand turn to avoid the obstacles, and elected to carry out a forced landing along a nearby road.

1.11 In the ensuing forced landing the aircraft sustained severe damage, having collided with fence posts and other obstacles. No fire occurred. The pilot and three passengers received minor injuries, and one passenger received serious injuries. The emergency services arrived shortly after the accident and the aircraft's occupants were taken to hospital.

1.12 The witnesses to the accident included two flight instructors from the Aero Club. They described the weather conditions as being calm, with a very high humidity and an air temperature in the "high 20's". They estimated the cloud base as about 2000 feet, with visibility in excess of 10 km. Information supplied by the Meteorological Service of New Zealand Ltd showed that Warkworth recorded a temperature of 21° C and a wind speed of two knots at 1500 hours. Whangarei recorded 23° C and Whenuapai 21° C at 1400 hours. The relative humidity at Whangarei and Auckland Airport at 1500 hours was 95% and 89% respectively. No readings however were available from Dairy Flat (North Shore Aerodrome) itself.

1.13 The witnesses reported that the aircraft appeared to accelerate normally during the initial part of its take-off roll, and that there was nothing unusual with the sound of the engine. They said the pilot "rotated early" in the take-off roll, and adopted a nose-high attitude with the nosewheel off the runway by the time the aircraft was abeam the clubhouse. From that point the aircraft did not appear to accelerate very quickly, and had used up "all the runway" before it got airborne. They described the aircraft as having "struggled or popped" into the air at the end of the runway and that the aircraft was below the level of the trees and did not climb. At no stage did the pilot attempt to abort the take-off.

1.14 The pilot advised that he had decided to use a short field take-off technique for the departure as an added safety margin to get airborne early. The aircraft's Flight Manual however required 25° of flap to be lowered for a short or soft field take-off and the aircraft allowed to accelerate to 40 to 53 KIAS depending on the aircraft weight before rotating to the climb attitude.

1.15 One of the aircraft's passengers said it seemed to take an "awful long time" for them to get airborne and that, when the aircraft did finally leave the runway, shortly afterwards they turned to the right and slid onto a road. The passengers did not notice a change in the "engine pitch" or loss of engine power.

1.16 The aircraft was secured by the Police, and the next morning it was examined. Control continuity was established and the flaps were found in the fully down position. No fuel remained in the fuel tanks as they had both been ruptured during the accident sequence. The fuel selector was set to the right tank. All of the aircraft was accounted for and there was no evidence to suggest it had malfunctioned.

1.17 The interior of the aircraft had been protected from moisture over night. The cargo contained in the aircraft was examined and weighed, and was in a dry condition. The cargo was stacked to the roof, with the heavier items on the bottom. It consisted of fishing equipment, food and drink, and personal items. The cargo was unrestrained, and some lighter items were found strewn on top of the cargo placed on the rear seat in a manner which suggested they had moved forwards from the top of the cargo in the rear baggage compartment, as a result of the decelerative forces during the accident sequence. Most of the cargo however was prevented from moving forwards due to its position behind the seats. The nose baggage compartment was empty of cargo.

1.18 The cargo in the rear baggage compartment was found to weigh 272.5 pounds (124 kg), and the cargo on the rear seats, and floor forward of the seats, weighed 200.5 pounds (91 kg). The fishing rods total weight was taken as having formed part of the weight at the rear seat station, as the heavy ends of the rods were positioned just behind the rear seats. For those lighter items that were determined to have moved forwards during the accident sequence, their original positions were used to calculate the centre of gravity (CG). The total cargo weight was 473 pounds (215 kg).

Weight and balance

1.19 The aircraft's empty weight was 2130 pounds (966 kg). Its allowable CG range at its maximum allowable all-up weight of 3600 pounds (1633 kg) was 91.2 inches (2316 mm) to 95 inches (2413 mm) aft of datum (AOD). The maximum baggage weight permitted in each baggage compartment was 100 pounds (45 kg).

1.20 Using the information recorded on the load sheet for the fuel, pilot and passenger weights, and the actual cargo weight, an all-up weight of 3753 pounds (1702 kg) was determined. The CG was calculated to be about 99.3 inches (2522 mm) AOD.

1.21 Assuming the pilot did depart from Auckland with 240 pounds (109 kg) of fuel, as he advised, and allowing for a fuel burn-off of 33 pounds (15 kg) to North Shore Aerodrome, including taxi and run-up fuel, the aircraft's weight would have been around 3660 pounds (1660 kg). The CG would have been some 99.5 inches (2527 mm) AOD.

1.22 The actual body weights of the passengers, as advised by the passengers, were 220 pounds (100 kg), right front seat, 198 pounds (90 kg), 198 pounds (90 kg) and 191 pounds (87 kg), for a total weight of 807 pounds (366 kg). The pilot's actual body weight was 185 pounds (84 kg). The standard passenger weight of 170 pounds (77 kg) for each occupant was used by the pilot, but the actual pilot and passenger weights amounted to an additional 142 pounds (64 kg).

1.23 Applying the actual pilot and passenger body weights to the two previous examples (see paragraphs 1.19 and 1.20), the aircraft's all-up weight would have been 3895 pounds (1766 kg), or 3802 pounds (1724 kg), respectively. The CG would have been around 99.5 inches (2527 mm) AOD, or 99.6 inches (2530 mm) AOD, respectively.

1.24 Aero Club staff said the passengers were "obviously" heavier than the standard weight, as they were very heavy set "like rugby players". The pilot advised that the passengers did not strike him as being overly big or heavy enough to be significantly outside the standard weight. The passengers said the pilot did not ask them their individual weights or weigh them. Two of the passengers said they were concerned they had too much cargo, and told the pilot to "feel free to leave some stuff behind". They said the pilot did not seem to be concerned about the cargo and loaded it all on board. They did not see the pilot weigh any of the cargo, or see him secure it.

1.25 A large set of approved platform scales was located in the departure lounge of the Aero Club's clubhouse and was available for the pilot's use. The Aero Club's CFI said the pilot was welcome to use the scales, but the pilot said that was not the impression he was under following his discussion, over the telephone, with the aerodrome's operator.

1.26 The company Operations Specifications required: "each item of baggage and goods (other than hand luggage) shall be weighed", when standard passenger weights were used. It also stated: "provided that standard passenger weights shall not be used when passenger loads consist mostly or entirely of persons whose weights are expected to fall outside the standard passenger limits, weight i.e. either heavier or lighter than the standard weight". The pilot advised that he had no knowledge of the company Operations Specifications and had not been shown any such document by the company.

1.27 The company Operations Manual however required all flight operations to: "be conducted in accordance with the provisions and requirements of the Operations Manual, the Operations Specifications, the relevant Flight Manual and with the Civil Aviation Regulations."

1.28 The company Operations Manual stated that for calculating passenger and baggage weights, standard weights could be used, or the individual passengers, baggage and cargo, weighed using accurate and approved scales. The manual also required cargo to be "held secure by nets" inside the aircraft. Cargo nets were supplied by the company and available at the company's premises at Auckland Airport.

1.29 The company Operations Manual was in the process of being amended at the time of the accident and the subsequent amendments included the words: "when any doubt exists as to actual passenger weights where a passenger is considered in excess of the standard weight then the passenger is to be weighed." The company Chief Pilot advised that the Operations Specifications formed part of the Operations Manual, and although the Operations Manual itself did not specifically contain the amendment at the time of the event pilots were expected to exercise common sense, in line with good aviation practice, and weigh passengers and cargo when any doubt existed as to them being heavier than standard.

Performance considerations

1.30 ZK-FMO had a Performance Group Rating of 8 at 1633 kg (3600 pounds). This required the aircraft to be operated from runways with a Group Rating Number of not less than 8, unless accurate calculation, using the aircraft's performance charts for the prevailing conditions and runway length available, indicated it complied with the take-off criteria.

1.31 Runway 03 at North Shore Aerodrome was paved, and had 0.3% uphill slope. The available take-off distance was 720 m, and it had a Group Rating Number of 6.

1.32 The take-off distance graph in the Flight Manual, supplement D, showed that ZK-FMO required some 1120 m of runway length for air transport operations, at 1633 kg (3600 pounds) and the conditions prevailing at the time.

1.33 Performance data in the aircraft's Flight Manual gave a required take-off distance of approximately 2600 feet (793 m) for a take-off weight of 3600 pounds (1633 kg), with no flaps and nil slope, in the prevailing conditions. This was "to clear a 50 foot obstacle"[2], and included a ground roll of some 1500 feet (457 m). However, as the aircraft was between 202 pounds (92 kg) and 295 pounds (134 kg) over its maximum permissible gross weight at the time, it would have required significantly more runway length.

[2] A theoretical screen. In practice the presence of actual obstacles in a take-off path requires that those objects themselves be cleared by at least 50 feet.

1.34 The Pilot's Operating Handbook for the aircraft, which was included in the Flight Manual, stated that: "the pilot must ensure that the airplane is loaded within the loading envelope before he makes a takeoff. Misloading carries consequences for any aircraft. An overloaded airplane will not takeoff, climb or cruise as well as a properly loaded one. The heavier the airplane is loaded, the less climb performance it will have. Centre of gravity is a determining factor in flight characteristics. If the C.G. is too far aft, the airplane may rotate prematurely on takeoff or tend to pitch up during climb. Longitudinal stability will be reduced. This can lead to inadvertent stalls and even spins; and spin recovery becomes more difficult as the centre of gravity moves aft of the approved limit."

Pilot information

1.35 The pilot, male, aged 33 years, held a New Zealand CPL (A) and a Class 1 Medical Certificate valid until August 1996, with no restrictions. The CPL included a "C" category Instructor Rating. His total flying experience at the time of the accident was 354.1 hours. Flight time in PA32 series aircraft amounted to 13.6 hours, all in ZK-FMO. In the 30 days preceding the accident he had flown 9.2 hours, including 2.8 hours in ZK-FMO.

1.36 The pilot was employed by the company on 29 August 1995 on a part-time basis. In December 1995 he was made a "full-time" employee and was paid a retainer plus an hourly rate for hours flown. Previously he had worked as a part-time instructor for a company at Ardmore. The pilot's employment by North Island Air Services Ltd followed his successful type rating training in ZK-FMO. The training, which included a maximum all-up weight check and a Regulation 76 check, was completed on 29 August 1995.

1.37 The pilot was familiar with North Shore Aerodrome having operated there previously, albeit in lower performance aircraft. His maximum all-up weight check in ZK-FMO however was conducted at North Shore Aerodrome.

1.38 The pilot had flown to Great Barrier Aerodrome previously, and the Chief Pilot advised that he had carried out a training flight with the pilot to overhead the aerodrome. This was to satisfy the Regulation 77 requirements and included a briefing about the aerodrome.

1.39 The pilot advised that he was "happy" with the level of supervision by the company's Chief Pilot, and that the Chief Pilot was always able to be contacted. The pilot said he "felt fine" on the day of the accident. He did not feel under any undue pressure to go on the flight, and it was his only planned trip of the day. The Chief Pilot said that on the day of the accident he was with the pilot in the office prior to the flight and the pilot was under his supervision. The Chief Pilot however was not made aware that the flight was routing via North Shore Aerodrome.

Aircraft information

1.40 ZK-FMO, a Piper PA32R-300 Lance, serial number 32R-7780023, was constructed in 1976. It was fitted with a Lycoming IO-540-K1G5D engine. The aircraft's total time in service at the time of the accident was 2143 hours.

1.41 The most recent scheduled maintenance carried out on the aircraft was a 50 hour inspection on 29 December 1995. Maintenance Release number 3493 was issued, valid until 23 June 1996 or 2154 hours in service. The aircraft was approved for air transport operations, and it had been issued with a non-terminating Certificate of Airworthiness. No defects were recorded as outstanding on the aircraft at the time of the accident.

1.42 The pilot reported that the aircraft had a recent history of magneto problems and considered that a magneto fault could have contributed to the accident. He said that on the day of the accident, prior to leaving Auckland, he had a magneto drop outside the limits, however some ground running rectified the problem and no further problems were encountered.

1.43 On the 18 January 1996 ZK-FMO had displayed signs of rough running during flight. The aircraft was returned to the departure airfield and the problem rectified the next day. There was no record of any symptoms of rough running or engine problems in the following period prior to the accident.

1.44 Following the accident the aircraft's magneto assembly, including the harness and spark plugs, was examined and tested. No problem was found with any of the components that suggested they had malfunctioned at the time of the accident.

Additional information

1.45 The following extracts are from an article in the "New Zealand Flight Safety" magazine, June/July 83, titled: "weight & balance - it's got to be right".

> "The flight performance of an over-weight aircraft is reduced in virtually every parameter of flight except one - rate of descent! It has a higher take-off speed, longer ground run, reduced rate and angle of climb, lower maximum ceiling, shorter range, reduced cruising speed, increased stalling speed, higher landing speed and longer landing roll."
>
> "Improper loading can cause out-of-limit location of the c.g. and this can seriously impair control of the aircraft about the pitch axis (on large aircraft the roll axis as well)."
>
> "Generally, an aircraft becomes more unstable as the c.g. moves aft, and violent stall characteristics are frequently associated with this condition. Forward pressure on the control column and full nose-down trim may be necessary to keep the aircraft from pitching up into the stall."

2. Analysis

2.1 The overriding factor in this accident was the decision by the pilot to attempt to take-off with insufficient runway length available, for the prevailing conditions and weight of the aircraft.

2.2 The pilot was a "C" category Flight Instructor and Commercial Pilot, and therefore should have been familiar with performance considerations and weight and balance computations. He said he had checked the aircraft's performance charts, but elected to take-off on a runway unsuitable for the type of operation he was conducting, and the performance of the aircraft.

2.3 The load sheets prepared by the pilot did not reflect the actual situation with regard to fuel, pilot and passenger weights, and cargo weight. As a result the aircraft was some 242 pounds (110 kg) to 335 pounds (152 kg) heavier than indicated on the load sheet.

2.4 The aircraft's CG was calculated to be around 4½ inches (114 mm) aft of the rear limit. It was perhaps fortunate the aircraft did not reach a significant height, as control could well have been lost at a higher altitude with more serious consequences.

2.5 ZK-FMO had a Performance Group Rating of 8, and the longest runway at North Shore Aerodrome, runway 03, had a Group Rating Number of 6. ZK-FMO was therefore a poor choice of aircraft for the flight. The pilot was obligated to determine the aircraft's performance accurately, and adjust its weight accordingly, for the conditions and available runway length. Calculation showed that to comply with supplement D in the Flight Manual for air transport operations, the maximum AUW of the aircraft should have been around 1375 kg (3032 pounds), some 350 kg (772 pounds) to 392 kg (864 pounds) less than the aircraft's actual weight.

2.6 It was a company requirement to secure an aircraft's cargo with nets. Though nets were available to the pilot he did not take one with him in the aircraft, and the cargo was not tied down by any means. As a result, the cargo was unrestrained and potential existed for it to cause injury to the aircraft's occupants.

2.7 The pilot's feeling of being unwelcome at the Aero Club could have influenced his decision not to weigh the passengers and cargo, with a consequent desire to depart quickly. However, he had begun loading the aircraft before the discussion with the Aerodrome's operator, and the passengers told the pilot he did not need to take all the cargo. The passengers were heavier than the standard weight, and a set of platform scales was available to the pilot. The pilot therefore had the opportunity to determine the aircraft's loaded weight accurately, and adjust it accordingly.

2.8 The pilot may have been misled into thinking he could always use standard passenger and cargo weights, due to the absence of specific instructions to the contrary in the Operations Manual at the time. However the Operations Specifications clearly stated otherwise. Had the pilot exercised prudence and good aviation practice he would have established accurately the loaded weight of the aircraft.

3. Findings

3.1 The pilot was appropriately licensed and rated to conduct the flight.

3.2 The aircraft had been maintained in accordance with approved maintenance schedules, and was airworthy at the time of the accident.

3.3 The aircraft had a valid Maintenance Release and Certificate of Airworthiness.

3.4 The aircraft's all-up weight at take-off exceeded the maximum authorised take-off weight.

3.5 The aircraft's centre of gravity was beyond the aft limit.

3.6 The information recorded on the aircraft's load sheet did not reflect the actual load on board the aircraft.

3.7 The aircraft's all-up weight was in excess of that appropriate for the available runway length and type of operation.

3.8 The Runway Group Number was less than the aircraft's Performance Group Rating number.

3.9 The cargo weight had not been established accurately.

3.10 The cargo weight exceeded the recorded value.

3.11 The aircraft's rear cargo compartment was overloaded.

3.12 The pilot did not comply with the Company Operations Manual procedure to restrain the cargo.

3.13 Standard passenger weights should not have been used for loading calculations, as the aircraft's occupants were heavier than standard.

3.14 The pilot did not comply with the requirement of the company's Operations Specification to weigh the passengers and cargo.

26 June 1996

M F Dunphy
Chief Commissioner

Addenda to

Aircraft Accident Report 96-009

Piper PA32R-300 Lance

ZK-FMO

North Shore Aerodrome

18 February 1996

Abstract

The pilot-in-command of ZK-FMO submitted further information relating to this accident for consideration by the Commission. This information related to the effect of a misaligned contact breaker assembly arm in the dual magneto of the aircraft engine, the timing of amendments to the company operations manual, the interpretation of an instruction on the company's aircraft load sheet, the flap setting which he used for the take-off and the distribution of the load in the aircraft.

The review of this new information, by a Commission Assessor and Senior Inspector of Air Accidents who were not involved in the investigation of this accident, found that the additional information submitted by the pilot warranted amendments to the Commission's reference to each of these areas in its Aircraft Accident Report 96-009. These addenda are discussed and detailed herein.

The Commission's opinion as to the causal factors involved in this accident was not altered significantly by the review of the information submitted but the Commission recognised that a possibility existed that some reduction in engine power during the take-off and attempted climb may have been the final event which reduced the already eroded performance margins of the aircraft to the extent that the accident was inevitable.

1. New evidence

1.1 The new evidence submitted by the pilot-in-command was reviewed by the Commission's Senior Inspector of Air Accidents and an independent Assessor.

1.2 The Transport Accident Investigation Commission (TAIC) Aviation Occurrence Report 96-009 took into account the weight of the aircraft, the aft position of the aircraft's CG, the pilot's take-off technique, the aerodrome characteristics and the prevailing weather conditions but gave no prominence to the possibility of reduced engine power during the take-off.

1.3 This omission was deliberate and based on the statements of the pilot that the engine was operating normally immediately before take-off, witness statements that the engine operated normally throughout the take-off and the subsequent assessment by an aircraft engineer that the dual magneto was serviceable.

1.4 The pilot drew attention to some independent engine tests conducted on behalf of the Civil Aviation Authority (CAA) of New Zealand in which, in the later stages of testing, the dual magneto on the engine did not perform as required. Investigation of the magneto revealed a fault which the engineer conducting the tests determined to have the potential to cause the failure of one side of the magneto at any time.

Addendum 1

1.5 An additional paragraph is **added** to the abstract in the report as follows:

> **However the possibility existed that, in addition to the above factors, a misaligned contact breaker arm in the right hand magneto resulted in some reduction in power which may have been the final factor leading to the accident.**

2. Amendments to the operations manual

2.1 TAIC report 96-009 states in paragraph 1.29 that "the company operations manual was in the process of being amended at the time of the accident and the subsequent amendments included the words...."

2.2 Evidence produced since the report was published establishes that the operations manual was amended as a result of the accident and not earlier as had been stated in evidence to the TAIC.

2.3 The TAIC report also states in paragraph 1.29 that ". . . the company Chief Pilot advised that the Operations Specifications formed part of the Operations Manual and . . ."

2.4 Contrary to the Commission's understanding at the time of its original report:

- the Chief Pilot has indicated that the Operations Specifications did not form part of the Operations Manual, but were maintained as a separate document which was attached to the Operations Manual.
- the pilot-in-command has given evidence that the Operations Manual he consulted did not have the Operations Specifications attached, and the Chief Pilot has accepted that this may be correct.
- at the time of the accident ZK-FMO was not entered in the Company Operations Specifications as an aircraft approved for air transport operations. (The required interchange of information concerning the use of ZK-FMO had taken place between the operator and CAA but due to an administrative oversight the relevant documents had not been amended.)

Addendum 2

2.5 **Amend** the first sentence of paragraph 1.29 of the report to read:

> **"The company operations manual was amended three days after the accident to include the words..."**

and in the second sentence **delete** the words

> **"the Operations Specifications formed part of the Operations Manual, and"**

3. Company Load Sheet statement

3.1 The company load sheet had printed on it the following statement:

> If any runway distance to be used is less than 700 metres check take-off performance to establish the need to operate at a weight less than the maximum approved for take-off.

3.2 While intended to enhance safety, this statement had the potential to confuse, and mislead, because of the implied corollary that for a runway distance greater than 700 metres, take-off performance at maximum approved weight would not require checking.

3.3 This statement is not relevant to the accident at North Shore Aerodrome because the pilot-in-command stated that he did check the performance charts for the aircraft before take-off.

Addendum 3

3.4 Additional paragraphs 1.32a and 1.32b are **inserted** as follows:

1.32a An instruction on the company's loadsheet read

> **If any runway distance to be used is less than 700 metres check take-off performance to establish the need to operate at a weight less than the maximum approved for take-off.**

1.32b Although the wording of the instruction had the potential to imply, misleadingly, that for a runway distance greater than 700 m the take-off performance would not require checking, this was not relevant to the circumstances of the accident as the pilot-in-command stated he had checked the performance charts for the aircraft before take-off.

4. Flap setting for take-off

4.1 The pilot-in-command, when interviewed one day after the accident, said that he used 10° of flap for take-off. He was adamant in a later statement made some 14 weeks after the accident that he had used 10° of flap not 25°.

4.2 However, recalling the circumstances of the flight more recently, and taking into account a reported illumination of the "gear unsafe" warning light when airborne, and the position of the flap selector lever before the aircraft was moved from the accident site, the pilot-in-command now says he is convinced that he did use 25° flap for take-off.

4.3 The substantial damage to the airframe and the absence of photographs or a video record or other definitive evidence of the flap setting during the take-off, preclude a conclusion as to the take-off position of the flap. In the light of this the firm statements by the pilot made closer to the accident are preferred and no change has been made to the report.

5. Previous magneto defects and rectification

5.1 The pilot-in-command was also concerned that the investigation did not take into account the history of defects and rectification related to the magneto on the aircraft engine. To record the history considered by the Investigator-in-Charge the following amendments are made.

Addendum 4

5.2 **Insert** new paragraph

1.42a On 16 January 1996 the left hand capacitor of the dual magneto fitted to ZK-FMO had been replaced, and the ignition switch assembly and the sparking plugs had been cleaned and checked.

and **amend** paragraph 1.43 to read

1.43 On 18 January 1996 ZK-FMO displayed signs of rough running during flight. The aircraft was returned to the departure aerodrome. The magneto was inspected and adjustments made to the right hand contact breaker assembly prior to the return flight to Auckland.

Insert new paragraphs

1.43a The next day, 19 January 1996, the magneto was removed and bench tested. A new right hand capacitor and right hand contact breaker assembly was installed. Ground running checks resulted in further checking and cleaning of the ignition switch contacts.

1.43b There was no record of any symptoms of rough running or engine problems in the 30 days prior to the accident.

5.3 Although the engine had been through the shocks involved in the accident and had not been in secure storage between the time of the accident and the day of the tests the results were accepted by the Commission which made the decision to run the engine again on an independent test bed.

6. Post-accident engine tests

6.1 Inspection of the dual magneto confirmed that the right hand contact breaker assembly arm was misaligned to the extent that a potential for grounding through the base plate existed. However when run on a bench test rig, the dual magneto performed satisfactorily and showed no tendency for the right hand contact breaker to ground.

6.2 The engine with the magneto installed in the "as received" condition, was mounted on a mobile test bed using a substitute ignition harness as the original could not be located. The engine produced full power and performed consistently throughout the test range during a series of

tests. There was no indication of an intermittent or sustained, loss of power due to the grounding of the misaligned contact breaker or for any other reason.

6.3 Electrical tests showed that grounding of the contact breaker assembly could be induced by light pressure on the misaligned arm. In this situation the magneto was either grounded or it was not. Deliberate grounding of the right hand magneto while the engine was producing full power resulted in an rpm drop from 2700 to 2500 rpm. There was no evidence that the grounded magneto adversely affected the engine timing, or was likely to have reduced the performance of the engine in any other way.

6.4 This new evidence of the misalignment of the right hand contact breaker assembly arm established a potential for the grounding of the right hand side of the dual magneto and a consequent loss of between 5% and 8.7% power[1].

6.5 The factors mentioned in the report were sufficient in themselves to make a successful take-off unlikely. The pilot-in-command confirmed that he had full power at the commencement of the take-off and at no stage attempted to discontinue the take-off roll. Nevertheless it is conceivable that a reduction in engine power during the latter part of the take-off or in the initial climb could have been the final event which rendered the accident inevitable.

6.6 The pilot-in-command says he is convinced that a loss of engine power did occur, which prompted him to abandon the attempt to climb the aircraft after take-off. On the other hand the tests conducted by the TAIC demonstrated that despite the misaligned contact breaker assembly arm, the engine was capable of producing full power with no tendency, under the test conditions, for a loss of power to occur.

6.7 No conclusive reason for the difference between the CAA and the TAIC tests was found. Both testbeds used flexible mounts to absorb vibration but, at the time of the CAA tests, considerable rough running was encountered initially due to fouled spark plugs when the engine was first started which may have accentuated the potential for any grounding problem. Variation in the test beds and the test clubs (propellers) may have also led to an increased level of vibration during the CAA tests.

6.8 An important consideration relates to the condition of the dual magneto at the time of the CAA and TAIC tests. The possibility could not be eliminated that some alteration had taken place whether prior to the CAA tests, as a result of the CAA test programme and subsequent inspection of the magneto, or during the 18 month period which elapsed between the tests conducted by the CAA and the TAIC. In particular, any change of the torque of the securing bolt on the right hand contact breaker arm assembly with a consequent effect on the "looseness" of the misaligned arm or an alteration of the clearance of the arm from the base plate could have affected the subsequent sensitivity of the right hand magneto to the grounding problem.

6.9 The lack of continuity of evidence also applies to the time which elapsed between the accident and the conduct of the CAA tests. In addition the effect of the impacts during the accident sequence cannot be determined.

6.10 While there must remain the possibility that the right hand magneto may have grounded, with the resulting loss of power, the safety factors built into the loading and performance requirements for take-offs on air transport flights could be expected to absorb the loss of power resulting from a grounded contact breaker arm and to enable a successful take-off and climb to be accomplished.

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[1] Based on information from the aircraft manufacturer including the result of dynamometer testing by the manufacturer of the engine.

6.11 In this instance however the significant amount by which the maximum authorised weight of the aircraft was exceeded, allied with the aft CG position and reported aircraft attitude during the aircraft take-off roll was likely to have eroded the safety margins to such an extent that the accident was a probability and no margin remained for the possibility of a power loss.

Addendum 5

6.12 An additional paragraph is **added** to the report as follows:

1.44a Independent engine tests were conducted on behalf of the Civil Aviation Authority of New Zealand in which, as the tests progressed, the right hand magneto of the dual magneto on the engine did not perform as required. Investigation of the magneto revealed a fault which the engineer determined to have the potential to cause the failure of the right hand side of the dual magneto at any time. Inspection of the dual magneto confirmed that the right hand contact breaker assembly arm was misaligned to the extent that a potential for grounding through the base plate existed. However when run on a bench test rig during later tests, the dual magneto performed satisfactorily and showed no tendency for the right hand contact breaker to ground. This new evidence of the misalignment of the right hand magneto contact breaker assembly arm established a potential for the grounding of the right hand magneto and a consequent loss of between 5 and 8.7 % power.

7. CG position

7.1 Paragraph 2.4 of the TAIC report states:

> The aircraft's CG was calculated to be around 4½ inches (114mm) aft of the rear limit.

7.2 The pilot-in-command claims that he had distributed the load in a manner different to that established by the Investigator-in-Charge. An investigation was therefore conducted to see if it was practicable to stow the load recovered far enough forward to bring the CG forward of the aft limit without any being stowed in the forward locker. The best that could be achieved was on the aft limit and this involved some unlikely positioning of items.

Addendum 6

7.3 Because there is an element of doubt about the precise disposition of the load in ZK-FMO paragraph 2.4 is **amended** to read:

> **The aircraft's CG was calculated to be around 4½ inches (114 mm) aft of the rear limit. The estimated CG was based on the "as found" disposition of the cargo. The pilot claimed however, that the load when the aircraft was examined following the accident, did not represent accurately the pre-take-off load distribution. While minor variations to the pre-take-off load distribution may have occurred during the impact sequence and aircraft recovery from the accident site, a realistic appraisal of the cargo placement supported the probability of a CG position rearward of the aft limit. In the event that the CG was beyond the aft limit it was perhaps fortunate that the aircraft did not reach a significant height, as control could well have been lost at a higher altitude with more serious consequences.**

. (new paragraph 3.15

3.15 The possibility existed that some reduction in engine power during the take-off and attempted climb was the final event which reduced the already eroded performance margins of the aircraft to the extent that an accident was inevitable.

Approved for publication 5 August 1998

Hon. W P Jeffries
Chief Commissioner

Glossary of Aviation Abbreviations

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
AOD	Aft of datum
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
^{o}C	Degrees Celsius
CAA	Civil Aviation Authority
CASO	Civil Aviation Safety Order
CFI	Chief Flying Instructor
C of A	Certificate of Airworthiness
C of G (*or* CG)	Centre of gravity
CPL (A *or* H)	Commercial Pilot Licence (Aeroplane *or* Helicopter)
DME	Distance measuring equipment
E	East
ELT	Emergency location transmitter
ERC	Enroute chart
ETA	Estimated time of arrival
ETD	Estimated time of departure
^{o}F	Degrees Fahrenheit
FAA	Federal Aviation Administration (United States)
FL	Flight level
ft	Foot/feet
g	Acceleration due to gravity
GPS	Global Positioning System
h	Hour
HF	High frequency
hPa	Hectopascals
hrs	Hours
IAS	Indicated airspeed
IFR	Instrument Flight Rules
IGE	In ground effect
ILS	Instrument landing system
IMC	Instrument meteorological conditions
in	Inch(es)
ins Hg	Inches of mercury

kg	Kilogram(s)
kHz	Kilohertz
KIAS	Knots indicated airspeed
km	Kilometre(s)
kt	Knot(s)
LAME	Licenced Aircraft Maintenance Engineer
lb	Pounds
LF	Low frequency
LLZ	Localiser
Ltd	Limited
m	Metre(s)
M	Mach number (e.g. M1.2)
°M	Degrees Magnetic
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
mm	Millimetre(s)
mph	Miles per hour
N	North
NDB	Non-directional radio beacon
nm	Nautical mile
NOTAM	Notice to Airmen
NTSB	National Transportation Safety Board (United States)
NZAACA	New Zealand Amateur Aircraft Constructors Association
NZDT	New Zealand daylight time (UTC + 13 hours)
NZGA	New Zealand Gliding Association
NZHGPA	New Zealand Hang Gliding and Paragliding Association
NZMS	New Zealand Mapping Service map series number
NZST	New Zealand Standard Time (UTC + 12 hours)
OGE	Out of ground effect
okta	Eighths of sky cloud cover (e.g. 4 oktas = 4/8 of cloud cover)
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	Second(s)
S	South
SAR	Search and Rescue
SSR	Secondary surveillance radar
^{o}T	Degrees True
TACAN	Tactical Air Navigation aid
TAF	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	VHF omnidirectional radio range
VORTAC	VOR and TACAN combined
VTC	Visual terminal chart
W	West