No. 96-003

Cessna 337

N10R

Near Whakatane

17 January 1996

Abstract

At approximately 1010 hours on Wednesday 17 January 1996, Cessna 337 N10R became airborne briefly in an attempted take-off from a farm paddock near Whakatane Aerodrome. The aeroplane failed to remain airborne, landed heavily and sustained substantial damage. Causal factors were insufficient take-off space and inappropriate pilot technique.

Transport Accident Investigation Commission

Aircraft Accident Report No. 96-003

Aircraft type, serial number and registration:	Cessna T337B, 606, N10R
Number and type of engines:	2 Continental TSIO-360-A
Year of manufacture:	1967
Date and time:	17 January 1996, 1010 hours* (approx)
Location:	2.5 nm west of Whakatane Aerodrome Latitude: 37° 55.6' S Longitude: 176° 52.0'E
Type of flight:	Private
Persons on board:	Crew: 1 Passengers: 1
Injuries:	Crew: 1 Minor Passengers: 1 Nil
Nature of damage:	Substantial
Pilot-in-Command's Licence:	United States Commercial Pilot Certificate (Airplane) New Zealand Private Pilot Licence (Aeroplane)
Pilot-in-Command's age:	23
Pilot-in-Command's total flying experience:	750 hours (claimed) 300 on type
Information sources:	Transport Accident Investigation Commission field investigation
Investigator in Charge:	Mr A J Buckingham

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

1. Factual Information

1.1 On Wednesday 17 January 1996, the pilot's intention was to fly his aeroplane from a farm paddock, where it had been parked for some weeks, to Whakatane Aerodrome, 2.5 nm to the east.

1.2 The paddock was located to the south of State Highway 3, from which it was separated by one other paddock. (Further references to the two use the terms "lower paddock" and "road paddock" respectively.) Along the boundary between the two paddocks ran a gravelled cattle race, bounded by two semi-permanent electric fences. The road paddock sloped upward slightly from the race to the road, at a gradient estimated at not more than 1%.

1.3 In order to utilise the maximum take-off distance available, the pilot and four local residents (one of whom was the pilot's intended passenger) removed some of the posts supporting the electric fences and secured the fence wires to the ground. Using a portable GPS set, the pilot determined that he had a total distance of about 400 m available between the road fence and the farthest fence in the lower paddock.

1.4 An 11 kV power line, on poles 28 feet high, ran adjacent to and parallel to the road, just outside the boundary of the road paddock. On the opposite side of the road was a shelter belt of trees which had been topped to about the same height as the power line.

1.5 The pilot decided that he would start his take-off roll from one corner of the lower paddock, taking off towards the road on a heading of about 020° M. He based this decision on his observation of the wind (from some 30° to the left of his intended take-off path, at "two or three knots") and his perception that the lower paddock was softer than the road paddock, in other words he would be running onto firmer ground as the take-off roll progressed. The pilot noted that the OAT gauge was showing 25° C. His estimate of the aircraft weight was 3500 pounds[1], the maximum certificated take-off weight being 4300 pounds.

1.6 After startup, the pilot, with his passenger, taxied the aeroplane from its parking position near the cattle race, towards the road. The other three persons who had assisted with the securing of the fence wires watched the aeroplane from a corner of the lower paddock, near the cattle race. From the road paddock, the pilot taxied along the reciprocal of his intended take-off heading to assess the effects of the surface conditions. At the completion of the taxi run, he lined the aeroplane up for take-off and applied full power, releasing the brakes only when he was satisfied that full power (32 inches MAP and 2800 rpm) was indicated on both engines. The take-off was commenced with the normal take-off flap setting of 1/3.

1.7 Before reaching the cattle race, the pilot raised the nose of the aeroplane, anticipating lift-off shortly thereafter. However, the aeroplane did not get airborne until it was well into the road paddock, and the pilot realised about this time that he was not going to clear the power lines ahead. He banked the aeroplane to the left in an attempt to turn and fly parallel to the power lines, but after a minimal heading change, and having crossed the fence to the left of the take-off path, the aeroplane sank heavily onto the ground. The left wingtip struck the ground first, after which the aeroplane slewed through 180°, skidding to a halt in approximately 43 m.

1.8 The right main undercarriage leg and the nosewheel separated from the aircraft before it came to rest, some 7 m from the road boundary fence. Other damage included an upward bend in each outer wing section, crush damage to the lower fuselage, bent propellers and a broken windscreen. The main cabin door was jammed shut by the damage to the fuselage, and both occupants vacated through the hole in the broken windscreen.

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[1] The units available to the pilot from the Flight Manual are used throughout this report.

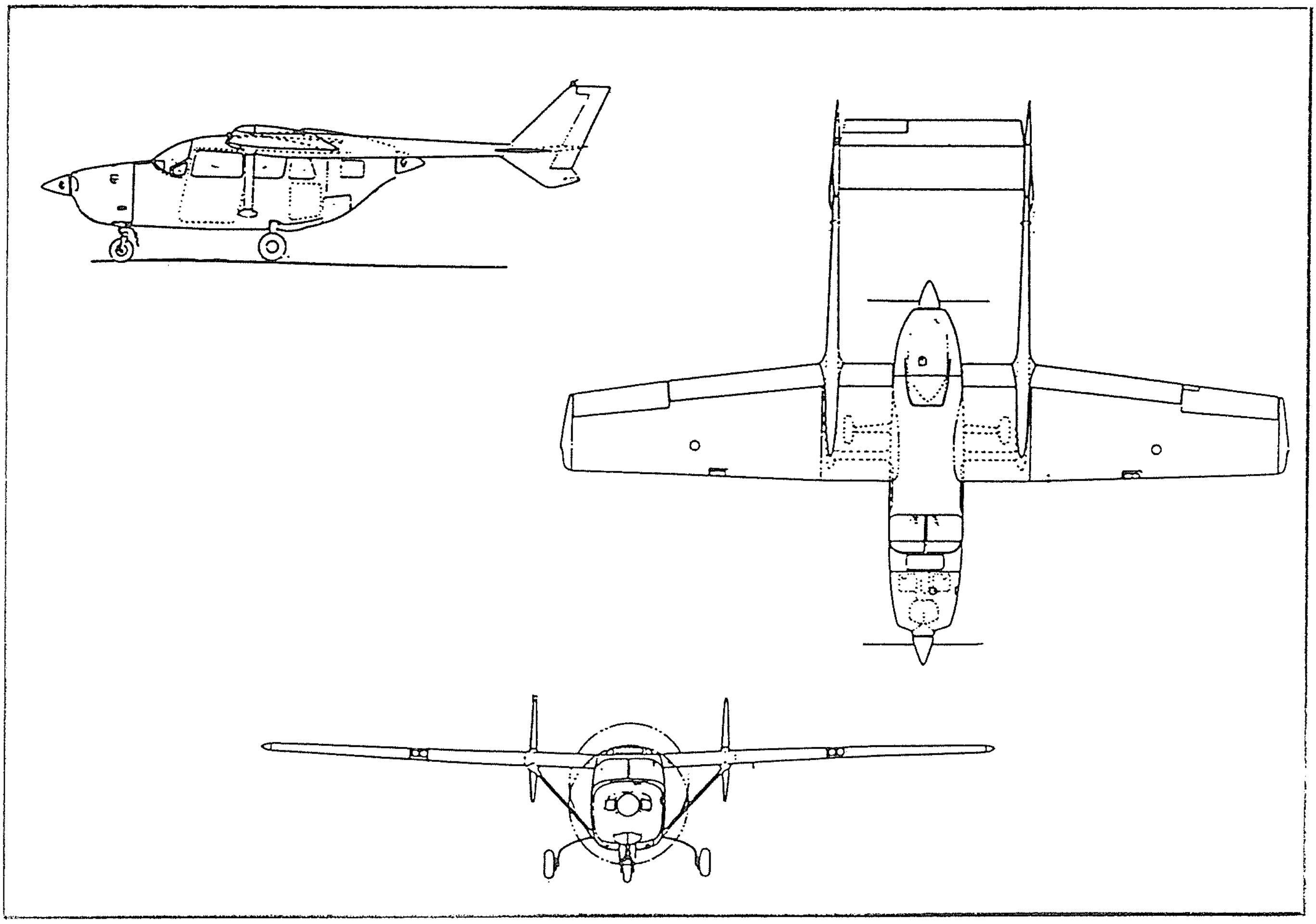

Figure 1
3-view diagram of (unmodified) aircraft, showing distinctive configuration

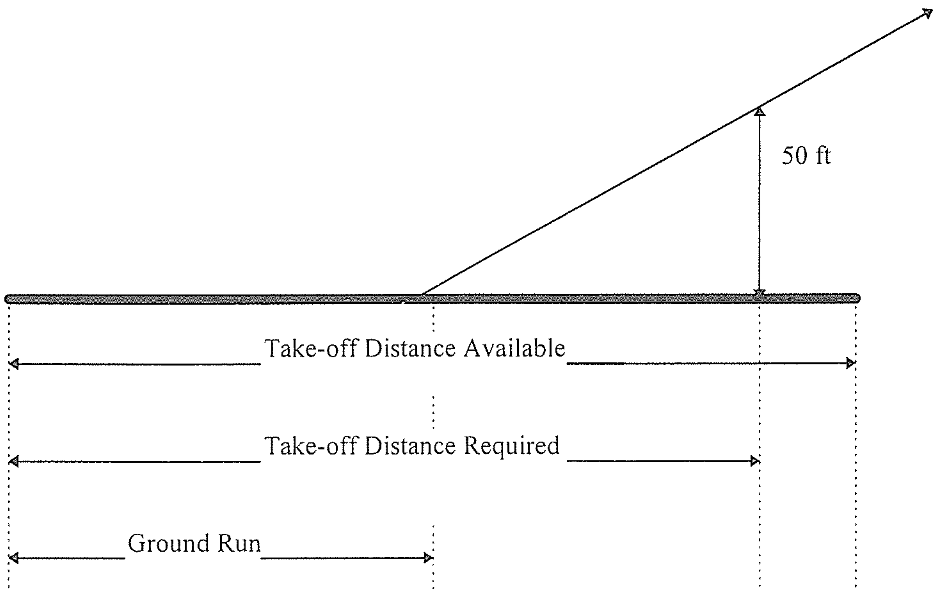

Figure 2
Definition of terms

1.9 The pilot sustained a minor laceration to his chin, and was saved from more serious injury by his protective helmet, which bore evidence of having struck part of the aircraft structure during the accident sequence.

1.10 One of the witnesses who observed the take-off estimated that the aeroplane reached a height of "15 to 20 feet", and another estimated the height as "half way up the power pole". Both of these witnesses said that the engine sound did not vary during the take-off attempt, and the passenger aboard the aeroplane was of the same opinion. The pilot, however, claimed that he noticed the fuel flow on the rear engine "go just over the red line" in the latter stages of the take-off attempt.

Pilot and aircraft information

1.11 The pilot, a New Zealand citizen, was issued with a New Zealand Private Pilot Licence (Aeroplane) in June 1993. He continued flying training in the United States, where he subsequently obtained a Commercial Pilot Certificate (Airplane).

1.12 In May 1995 he acquired Cessna 337 N10R. After making the necessary ferry modifications, he flew the aeroplane to New Zealand in September 1995, with the intention of establishing a charter operation. In October, he relocated the aeroplane from Auckland International Airport to the paddock (on a relative's property) near Whakatane.

1.13 The aeroplane was equipped with a Horton STOL[2] conversion kit, comprising a leading edge cuff, modified ("drooped") wingtips, a chordwise wing fence located on the upper surface of each wing, inboard of the ailerons, vortex generators on the lower rear engine cowl and upper and lower fin/tail boom fairings.

1.14 A sample FAA-approved Flight Manual Supplement supplied by the manufacturer of the STOL kit contained the following information:

> "SECTION 4 NORMAL PROCEDURES: There is no change to the normal procedures with the installation of the Horton STOL-KIT."

1.15 The manufacturer indicated that flight testing had been done on several models of the Cessna 337 fitted with the kit, but only to investigate handling characteristics at low speeds and recovery from unusual attitudes. No quantitative claims were made for performance other than that tabulated in the original Flight Manuals, and the only claimed benefits were a slight reduction in stall speed, and improved handling qualities at low speeds.

Performance considerations

1.16 Performance data in the Pilot's Handbook in N10R gave a required take-off distance of 1110 feet for a take-off weight of 3500 pounds, in nil wind, off a hard-surfaced runway at sea level under ISA conditions. This distance was "to clear a 50-foot obstacle", and included a ground run of 535 feet. The performance table gave 77 mph as the speed to be attained at the 50-foot point. (See Figure 2 for an explanation of various terms used in this section.) The 1000 hours data from the automatic weather station at nearby Whakatane Aerodrome showed the wind as 250° T, 4 knots, temperature 23° C and QNH 1013 hPa. The elevation of the paddock was close to sea level.

[2] Short take-off and landing, although the manufacturer uses the term "Safer Take-Off and Landing" in promotional material.

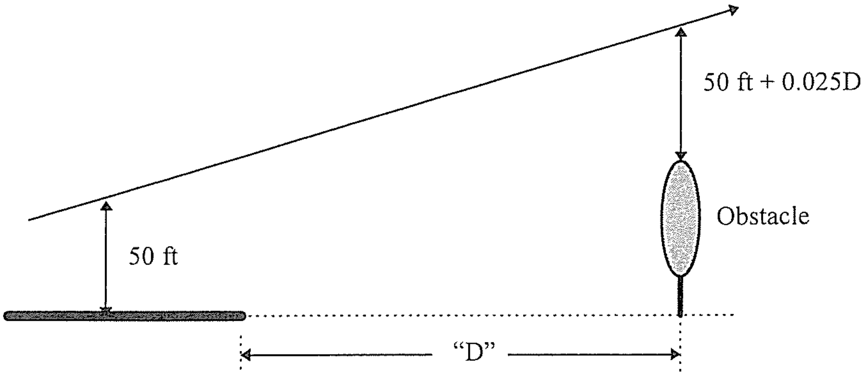

Figure 3
Obstacle clearance
This example uses the criteria set out in CASO 4, Part 5, by way of illustration.

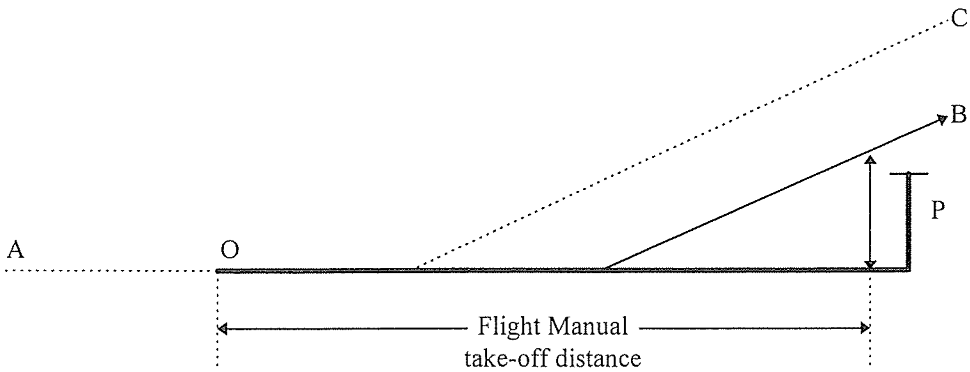

Figure 4
Line OB represents a take-off path. Placing obstacle P in the position shown will require displacement of the take-off path in order to achieve obstacle clearance. Line AC becomes the new take-off path, presupposing that the space AO is available for use.

1.17 Notes appended to the take-off performance table instructed the user to "Increase distances 10% for each 20° F above standard temperature for particular altitude" and "For take-off on dry grass runway, increase distances (both "ground run" and "total to clear 50 ft obstacle") by 10% of the "ground run" distance". Adding 20° F to sea-level ISA temperature of 59° F gives 79° F which converts to 26° C - close to what the pilot saw on his OAT gauge. Applying the temperature and grass corrections to the basic distance of 1110 feet gives a required take-off distance of 1280 feet (390 m), which includes a new ground run distance of 589 feet (180 m).

1.18 The expression "50-foot obstacle" referred to in the performance data can be misleading. During certification flight testing of an aircraft type, the take-off distance is determined using standard FAA certification criteria of 50 feet and 1.2 V_S, that is, the take-off distance includes the ground run plus the airborne distance required to reach 50 feet at 1.2 V_S (in this case the 77 mph given in the table). The 50-foot "obstacle" is in fact a theoretical screen, and in practice, the presence of actual obstacles in a take-off path requires that those obstacles themselves be cleared by at least 50 feet. This is illustrated in Figure 3.

1.19 Taking into account the presence of physical obstacles in the path of N10R, in the form of 28.7-foot high power lines, the effect on the required take-off distance is shown in Figure 4. The origin of the required take-off distance is then displaced to about 1667 feet (508 m) from the obstacle, basing the calculations solely on the Flight Manual performance. However, the actual take-off commencement point was constrained by the presence of a permanent fence and an adjacent small watercourse, and based on a 1:20 obstacle clearance gradient, the actual take-off distance available was only about 200 m. There is no consideration of the effects of the failure of one engine on any of these figures.

1.20 The surface of the lower paddock used in N10R's take-off attempt was rough and slightly soft, with grass up to 20 cm high. Each of these surface characteristics would have had the effect of further increasing the ground roll and therefore the total take-off distance required.

1.21 The pilot had cited the wind direction and the softness of the lower paddock as reasons for his choice of take off direction. However, advantages noted in favour of the reciprocal heading were the better surface of the road paddock, and only a standard fence to clear, with sufficient clear space beyond for acceleration if necessary. The effect of the wind would have been negligible.

Site investigation

1.22 Post-accident measurement of the wheel marks of N10R on the grass surface showed a total ground roll of 310 m (1017 feet), and that the pilot had raised the nosewheel some 204 m (669 feet) into the take-off roll. The rotation had been continued to an attitude in which the lower portions of the twin tail fins had contacted the ground, which equates to a body angle of about 16°. The marks left by the tail fins commenced 14 m past the point where the nosewheel left the ground, and continued for a further 15 m. They ceased part way across the cattle race, where the wheel marks indicated that the aeroplane had "skipped" momentarily into the air off the raised crown of the race. The depth of the tail fin marks, together with a trail of paint flakes indicated that the lower fins were pressed onto the ground with appreciable force and that they would have received a considerable jolt on striking the race.

1.23 Beyond the race, the imprints of the two main wheels were visible for a further 72 m, to where the aeroplane lifted off. The character of the wheel marks changed over the final 16 m, suggesting that braking had been applied over that distance. The distance from the point where the aeroplane lifted off to where it contacted the ground again in the neighbouring paddock was about 70 m.

1.24 The right lower tail fin on N10R had sustained damage consistent with the impact sequence, but the damage to the left lower fin was minor by comparison, and could have occurred when the fin struck the cattle race. The damage to the left fin was sufficient to restrict the travel of both rudders between full left deflection and approximately 5° left deflection, i.e. there was no right rudder deflection available.

2. Analysis

2.1 The dominant factor in this accident was the inadequate space for a successful take-off. While there was almost 400 m available between fences, no account was taken of the presence of the power lines at the departure end. The take-off distance required on grass in the prevailing conditions was at least 390 m, which included a ground run of 180 m.

2.2 However, the grass surface correction figures in the Flight Manual assume short grass and a smooth, firm surface. The surface of the paddock in which the take-off run was commenced met none of these criteria, resulting in a significant increase in the ground run distance.

2.3 In addition, the vigorous rotation of the aeroplane to a nose attitude such that the tail fins contacted the ground had two adverse effects: the 16° nose-up attitude placed the wings at or close to the stalling angle of attack with consequent high drag, and the braking action of the fins dragging on the surface. The final 16 m of the ground run indicated possible wheel braking, which may have been unwittingly applied by the pilot as a reflex action when he saw his available options running out.

2.4 The combination of the surface conditions and the effects of the excessive nose-up attitude resulted in a measured ground run of 310 m, as against a Flight Manual figure of 180 m for a grass surface.

2.5 The aeroplane was probably flying at close to stalling speed when it became airborne. Thus, climb performance would have been minimal at this point, and it is unlikely, given the witness observations, that the aeroplane flew out of ground effect.

2.6 In such a situation, banking the aeroplane reduces the vertical component of lift, which will result in a descent. In this case, the attempt to turn achieved exactly that, and the aeroplane struck the ground heavily whilst in a left bank after a minimal heading change. At this point, the pilot's only other option would have been to continue straight ahead and collide with the power lines and trees in front of him.

2.7 It was evident from the pilot's account of events that he placed considerable faith in the additional performance provided by the STOL kit to enable him to fly into and out of confined areas, based on claimed past experience. However, the thrust of the information provided by the manufacturer was that, despite the beneficial effects of the kit (slight reduction in stall speed and improved control response at low speed), the aeroplane was still required to be operated in accordance with the approved Flight Manual.

2.8 Post-accident testing of the aeroplane's engines was not practicable owing to the extent of the damage, and in the circumstances, bulk stripping of the engines was considered to be outside the scope of the investigation. Had the fuel flow on the rear engine "gone just over the red line" as the pilot claimed, this should not have had a significant effect on engine power output. The pilot had checked the latter as being satisfactory early in the take-off sequence.

2.9 A take-off in the opposite direction was likely to have succeeded - the only obstacle to contend with in that direction was a standard farm fence, with clear space beyond in which to accelerate if necessary, and the better surface, with its slight slope, in the road paddock would have ensured a better initial acceleration.

3. Findings

3.1 The aeroplane was operating normally at the commencement of the take-off run, and probably was capable of doing so throughout the take-off attempt.

3.2 There was insufficient space available in which to achieve a normal take-off and subsequent obstacle clearance.

3.3 The ground run was increased by the rough surface and long grass in the paddock from which the take-off was attempted.

3.4 The ground run was further increased by the pilot's rotation of the aeroplane to an excessively nose-up attitude while still on the ground, and probable unwitting application of wheel brakes just prior to lift-off.

3.5 The aeroplane probably became airborne at a speed too low to yield any useful climb performance with respect to the obstacles ahead.

3.6 Banking the aeroplane reduced the vertical component of the lift vector sufficiently for it to sink back onto the ground.

3.7 The pilot had an unreasonably high expectation of the performance of the aeroplane, particularly in regard to the benefits of the STOL kit.

3.8 A take-off attempt in the opposite direction would probably have been successful.

26 June 1996

M F Dunphy
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
°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
°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)
^{o}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
°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