Report 97-017

air proximity incident

British Aerospace 146 ZQA 729 and Fairchild Metro EAG 165

near New Plymouth

21 December 1997

Abstract

At 1610 hours on Sunday 21 December 1997 a BAe 146 aircraft overtook a Fairchild Metro aircraft flying on the same track and at the same flight level, in controlled airspace. Both were on scheduled passenger flights. The estimated passing distance was 100 to 500 metres horizontally, and 20 to 150 feet vertically. Both aircraft were complying with their air traffic control clearances, and were under radar control. Neither of two radar controllers, in Auckland and Christchurch, had perceived the conflict between the aircraft.

Safety issues identified are:

- the desirability and difficulty of crews maintaining situational awareness of other traffic,
- controllers' use of basic flight progress strip and radar information,
- the implementation of short term conflict alert for air traffic control radar, and
- the adoption of traffic collision avoidance system equipment for aircraft.

Safety recommendations were made to the Director of Civil Aviation and to the Chief Executive of the Airways Corporation of New Zealand.

Transport Accident Investigation Commission

Aircraft Incident Report 97-017

Aircraft types, flight numbers and registrations:	British Aerospace 146-300, ZQA 729, ZK-NZL Fairchild SA 227 Metro EAG 165, ZK-RCA		
Date and time:	21 December 1997, 1610 hours[1]		
Location:	About 14 nm south of New Plymouth		
Type of flights:	Scheduled passenger transport		
Persons on board:	Crew:	ZQA 729:	5
		EAG 165:	2
	Passengers:	ZQA 729:	89
		EAG 165:	8
Injuries:	Nil		
Nature of damage:	Nil		
Investigator-in-Charge:	J J Goddard		

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

1. Factual Information

1.1 On Sunday 21 December 1997 Eagle Metro ZK-RCA, operating as EAG 165, was flying a scheduled service from Auckland to Woodbourne. Before departure, at 1523 hours, the crew had requested and received from Auckland Ground a standard route clearance "Woodbourne 2, flight level [FL] 220." This route was via New Plymouth, Tory and Blenheim.

1.2 EAG 165 was cleared for take-off by Auckland Tower at 1529 hours, and then proceeded routinely under radar control with Auckland Approach radar (TMR). Auckland TMR instructed the flight to contact Control (Auckland Area radar control) on 126.0 MHz at 1542 hours, which was promptly done.

1.3 Auckland Area acknowledged the aircraft climbing to FL 220, and instructed EAG 165 to contact Christchurch on 123.7 MHz at New Plymouth. No further communications took place between Auckland Area and EAG 165.

1.4 At 1606 hours EAG 165 contacted Christchurch Area radar control with a position report, "Crossed New Plymouth, flight level 220", which was acknowledged.

1.5 On the same afternoon Ansett 146 ZK-NZL, operating as ZQA 729, was flying a scheduled service from Auckland to Wellington. Before departure, at 1523 hours, and shortly after EAG 165 received its route and start clearance, the crew requested and received from Auckland Ground a standard route clearance "Wellington 2, FL 220." This route was via New Plymouth and Tory.

1.6 ZQA 729 was cleared for take-off by Auckland Tower at 1543 hours, and also proceeded routinely under radar control with Auckland TMR. Auckland TMR instructed the flight to contact Auckland Area radar control at 1553 hours.

1.7 Auckland Area acknowledged the aircraft climbing to FL 220, and instructed ZQA 729 to contact Christchurch at New Plymouth.

1.8 At 1608 hours, ZQA 729 contacted Christchurch Area radar control with a report, "Flight level 220". Christchurch Area acknowledged this, and amended the route clearance to Wellington to ". . . via Tory and Titahi Bay".

1.9 At this stage, both aircraft were flying in clear, sunny but hazy conditions. At about 1610 hours the first officer on ZQA 729 exclaimed, and drew the captain's attention to another aircraft in their one o'clock position, and slightly higher, which they were rapidly overtaking. The captain was able to assess that a collision avoidance manoeuvre was not needed, and they passed to the left of the Metro. As they passed, they reported to Christchurch Area, "We have just gone past a Metro same level". Christchurch Area acknowledged this and instructed them to turn left thirty degrees.

1.10 The crew of the Metro saw the BAe 146 as it overtook them. Estimates from both crews of the passing distance were 100 to 200 m horizontally and 20 to 150 feet vertically, with the Metro higher.

1.11 Both aircraft completed their flights without further incident.

1.12 The incident occurred within class C controlled airspace, in the Christchurch upper control area (UTA/C), where aircraft were required to operate with an air traffic control (ATC) clearance, and where air traffic services were required to provide separation between aircraft ". . . for the purpose of preventing collisions".

1.13 ATC radar was in use, and was the normal means of providing area control service. The minimum horizontal separation specified for flights under radar control in the UTA was 5 nautical miles (nm).

1.14 New Plymouth was on the boundary between the Raglan and Taranaki sectors of the Auckland and Christchurch control areas, and was where area control of aircraft on the route would normally be transferred from Auckland to Christchurch. The handover was normally an electronic procedure, with the receiving controller accepting control of each aircraft individually on the radar display screen by using keyboard controls. Verbal co-ordination, by telephone, between controllers would not normally occur unless there was something unusual about the transfer. However the Manual of Air Traffic Services (MATS) did require co-ordination to take place ". . . where controlled flights might conflict at or about contiguous ATS sector boundaries ..... to clearly establish which sector/unit is responsible for ensuring separation is maintained".

1.15 The Auckland Area radar controller who was controlling traffic north of New Plymouth was operating a sector which contained two separate portions of Auckland airspace one south of Raglan, the other north of Auckland. He was a qualified on-the-job instructor, and was instructing another controller who was training to validate as an Auckland Area controller.

1.16 This training session had occurred fortuitously, when the trainee's regular instructor had concluded his shift early. As the trainee controller was keen to continue, the instructor involved agreed to take over. Although the instructor knew the trainee well, as an Oceanic controller, he had not previously taught him, and was not familiar with his progress as an Area radar controller. No training review or preparation took place before the impromptu session.

1.17 Neither the student nor the instructor controller had any significant recollection of the two aircraft involved in the incident. They were not advised that the incident had occurred until some time after both aircraft had left the Raglan sector. At that point the instructor controller was relieved from duty, as was normal practice after an incident, while the student continued with another instructor.

1.18 During the 20 minute period before this incident, three unrelated and differing traffic situations had occurred, each of which presented good training value for the student, and which consequently had generated significant discussion between him and the instructor. The instructor thought that because he had so little recollection of the incident aircraft, he must have been distracted at the time.

1.19 The computer-generated flight progress strips for the two aircraft were issued to the Auckland Area controller before each aircraft came into his sector. They showed both aircraft cleared to FL 220, with estimated times of arrival (ETA) at New Plymouth for the Metro, EAG 165, of 1604 hours and for the BAe 146, ZQA 729, of 1606 hours.

1.20 The Christchurch Area controller was operating the Taranaki sector, south of New Plymouth, on his own. Earlier in the day the sector had been combined with the Kaikoura sector, with another controller at the position working as a planner, but the sectors had been separated and the planner position discontinued at the time of the incident.

1.21 When the Christchurch Area controller had accepted each aircraft in turn at New Plymouth he had looked at and identified each symbol on his radar display to do so, but he had not realised that they were at the same level, FL 220, with the BAe 146 closing quickly on the Metro. He was made aware of the incident by the radio call from the BAe 146, advising they had just passed the Metro. Shortly afterwards he was relieved from duty, as was normal practice.

1.22 The Christchurch Area controller commented that over the time the two aircraft were handed in to him he was busy with a traffic situation in the south of his sector; he had not received any warning from the previous sector controller of an impending problem, and had no expectation that such a problem could develop so close to a boundary without warning, unlike in the middle of his sector. In addition he saw a Metro and a BAe 146, and expected the Metro to be at a lower level - he had not seen one at FL 220 before. A further problem he encountered at the same time was with label clutter on his radar display - an aircraft departing from New Plymouth, climbing to FL 160, had "popped up" on his display in the vicinity of the two crossing aircraft, and its label orientation initially overlapped with one or other of their labels.

1.23 The computer-generated flight progress strips for the two aircraft were issued to the Christchurch Area controller some 21 and 15 minutes before the aircraft crossed the boundary into his sector. They showed both aircraft cleared to FL 220, with the ETAs at New Plymouth for the Metro, EAG 165, at 1605 hours, and for the BAe 146, ZQA 729, at 1607 hours.

1.24 The Christchurch Area controller explained that he had previously made a practice of cross-checking flight levels on each flight progress strip with his electronic data display (EDD). However the flight data processing system (FDPS) had been changed on 26 November 1997 to a single computer system, rather than separate computers in each centre, and since then he had ceased this practice as he thought it was no longer required.

1.25 The Christchurch Area controller had qualified for his Christchurch Area radar control rating on 7 November 1997. Before that he had been an approach and tower controller at Nelson for two years.

1.26 Both the Auckland instructor controller and the Christchurch controller were working normal shifts, after normal rest periods. Each thought the level of traffic at the time generated a normal or average workload.

1.27 The Airways Corporation radar computer system did not provide an STCA (short term conflict alert) facility to controllers. The installation of this facility, the subject of a previous safety recommendation by the Commission, is scheduled for completion by November 1998. Such a facility could have alerted either or both controllers to the incipient loss of separation in time for appropriate action to be taken to avert the unsafe situation which occurred.

1.28 Neither aircraft was equipped with TCAS (traffic collision avoidance system), nor was there a requirement for such equipment to be fitted within New Zealand. Such a system, quite independently of the ATC system, could have alerted either crew to the other aircraft at the same level in time for a call to ATC and an appropriate avoidance manoeuvre to be carried out.

1.29 Since the completion of the Airways Radar Modernisation Project, which introduced secondary radar to the ATC system, there had been no requirement for pilots of transponder-equipped aircraft to give full position reports at each reporting point. The only en-route reporting required was to advise call-sign and flight level on first contact with each ATC unit.

1.30 In this incident, EAG 165 did make a position report on crossing New Plymouth, but no other radio call made by either aircraft contained position information.

1.31 The radio calls in response, made by each controller, similarly contained no position information; just an acknowledgement with a readback of the flight level, and any appropriate instruction for the aircraft.

1.32 A plot of the recorded radar data showed that ZQA 729 passed some 500 m to the left of EAG 165 about 14 nm south of New Plymouth at 1610 hours. Both were at FL 220. When ZQA 729 crossed New Plymouth at 1608 hours it was about 5.5 nm behind EAG 165.

2. Analysis

2.1 This air proximity incident was of concern not just because the air traffic control minimum separation of 5 nm had been lost; not just because the aircraft passed by 100 to 500 m; but because the aircraft were cleared to fly along the same track at the same level with the faster one following and bound to overtake, with no awareness of the problem by any person or system. The principal reason why a collision did not occur was the tolerance of the navigation systems, which fortuitously spread the aircraft tracks and levels. The sighting by the crew of the overtaking BAe 146 did show that they were keeping a lookout, and would probably have permitted an avoidance manoeuvre if this had been necessary. However the aircraft could well have been in conditions where a sighting was not possible, and where the instrument flight rules (IFR) air traffic control system is meant to provide safe separation.

2.2 The three elements with any potential to influence the course of events leading to this incident were:

- the crews of the aircraft involved,
- the air traffic controllers who were controlling the aircraft before and around the time of the event,
- the ATC system which directed and regulated the crews and controllers, as well as defining the parameters and methodology of the operating environment.

2.3 The crews of the aircraft complied with the clearances issued by the controllers and operated their aircraft normally, so the flight paths were predictable and as intended by ATC.

2.4 The independent ability of the crews to monitor the position of their aircraft in relation to each other was principally limited by their awareness of the position and level of other traffic generally. This situational awareness has traditionally been achieved by crews, on an opportunity basis when other duties permit, being able to overhear radio calls between other aircraft and ATC, and from this building a mental picture of the traffic.

2.5 In this incident the only opportunities for one to hear the other's radio calls were for EAG 165, when ZQA 729 contacted Auckland Area and Christchurch Area in turn and reported climbing to or at FL 220. These calls did not include position reports, but the Auckland controller's response ". . . contact Christchurch at New Plymouth" could have provided some warning if it had been heard. ZQA 729 was unlikely to have heard any of EAG 165's calls, as they were guarding different radio frequencies on each occasion. While both crews could have heard the other's standard route clearance before departure from Auckland, the coded abbreviations "Woodburne 2" or "Wellington 2" would not have obviously indicated, without further reference, that each was via the same route.

2.6 The requirement, on first contact with each air traffic control unit, to only report flight level has reduced the opportunity for crews to maintain situational awareness of traffic around them. This reduced reporting requirement was intended to lessen radio traffic when the introduction of secondary radar made full position reports unnecessary for radar control, but it has had the side effect of reducing the monitoring capability of crews. In this incident, mutual awareness could have enabled either crew to query ATC, or to communicate with each other, if they had suspected their flight paths would conflict.

2.7 A safety recommendation was made to the Director of Civil Aviation to consider the reintroduction of position reports by the aircraft crew on first contact with each ATC unit.

2.8 It was of note that the Auckland Area controller, when acknowledging the initial call from each aircraft, had straight away instructed it to, ". . . contact Christchurch at New Plymouth", rather than as the aircraft neared the sector boundary, which was about 24 minutes and 15 minutes later, respectively. This reduced any opportunity for either crew to hear and appreciate their mutual proximity. If these calls had been made close to the sector boundary, their closeness in time would have been likely to alert both the crews and the controller to the situation.

2.9 Secondary advantages of the controller not issuing these contact instructions until aircraft approach the sector boundary are likely to be:

- more timely prompting of the crew to change frequency and make the next call,
- a routine scan of the aircraft positions on the display at that time by the controller,
- reassurance to the crews that the controller is actively monitoring their radar position, rather than the appearance of having accepted them into his sector and then giving them little further attention.

2.10 TCAS equipment has been required in aircraft in several countries for some years, but not yet in New Zealand. Its purpose is to alert crews to other traffic which might conflict with them, and where appropriate to advise what manoeuvre will resolve a danger. Many reports of its value have been made. This incident was a situation where TCAS could have provided advance warning, independent of ATC radar, before the loss of separation had occurred.

2.11 A safety recommendation was made to the Director of Civil Aviation that he expedite the process of making rules for the carriage and use of TCAS by appropriate aircraft.

2.12 The two controllers, Auckland Area/Raglan sector and Christchurch Area/Taranaki sector, obviously had the means to influence the events leading to this incident - it was in fact their principal function in relation to these aircraft to do so. However no action was taken, and neither was aware of the problem as it developed.

2.13 The Auckland Area controller's first available warning that the aircraft might conflict was when he received their flight progress strips from the printer, in advance of their crossing into his sector. Normal procedure then would be to insert these strips into strip holders of appropriate colour for north or south traffic, put them onto his board in appropriate positions for their geographic position, and compare their routes, times and levels to prepare himself in anticipation of any revised instructions which became necessary to maintain their separation while under his control. The controller would record on the strips updated information on clearances, ETAs and level instructions passed to the aircraft.

2.14 A controller's radar display shows each aircraft symbol on a map presentation, identified with a label displaying the current level, cleared level, climb indicator, weight category, groundspeed and destination or type. A velocity vector or distance apart information is also available. This is visible before an aircraft enters the sector, so a situation may be anticipated from the display as well as from the flight progress strips.

2.15 The Auckland Area controller was aware that the aircraft were on the same track, as demonstrated by his ". . . contact Christchurch at New Plymouth" instruction to each. When they entered his sector they were well separated, 11 minutes or about 30 nm apart, and climbing to FL 220, providing a good opportunity to plan how to separate them as they became closer. His subsequent lack of recollection of the aircraft indicated that he was not aware that they were climbing to the same level, in spite of the flight progress strip and radar display information. This lack of awareness of the aircraft at the same level, with the faster one behind and bound to overtake, may have stemmed from the initial large horizontal separation. It did, however, indicate a failure to scan and review the situation during the 15 minutes taken by ZQA 729 to cross his sector.

2.16 It is probable, by his own admission, that the controller was distracted by his instructing task, which involved significant discussion with the trainee about other traffic situations occurring over the same period. The unplanned nature of the training session may have influenced this, with the instructor giving more active instruction than was compatible with the level of supervision he was providing over the trainee.

2.17 The controller was well experienced, both on the position and as an instructor, and his lapse in scanning his traffic information may indicate some shortcomings in the training and methodology taught to instructors in the Airways Corporation ATS Training Plan.

2.18 If the controller had recognised the developing conflict, his course of action would have been to resolve it, probably by introducing vertical separation. Alternatively, as indicated by MATS, he would have co-ordinated with the Christchurch Area controller, by telephone, either what conflict resolution instruction to the aircraft would be best, or to hand the aircraft on early for resolution by the next controller.

2.19 Since no such action occurred, the aircraft arrived in the Taranaki sector on the point of losing separation, with 5.5 nm between them and ZQA 729 overtaking rapidly. This situation was unreasonable for the Christchurch Area controller to cope with, without warning, and a loss of separation was almost inevitable.

2.20 The Christchurch Area controller had no awareness of the problem, however, and the aircraft fortuitously passed each other. It was evident that he had not considered the level and time at New Plymouth information on the flight progress strips in relation to each other, which could have given some 15 minutes warning. His explanation about no longer cross-checking levels on the strips with the EDD since the recent change to a single FDPS computer was not directly related to this lapse, but may have subtly influenced his operating practice.

2.21 Considering and correlating flight progress strip information when it comes to hand is basic air traffic control working practice, yet both the experienced Auckland radar controller and the newly trained and qualified Christchurch radar controller failed to do so. This may indicate a shortcoming in training and checking on basic radar controller practice by the Airways Corporation. The radar displays of data labels may give controllers the information in a more dynamic and spatially related way, but are less likely to provide the advance notice of problems coming up, or may be neglected also, as in this incident.

2.22 It was recommended to the Chief Executive of the Airways Corporation that he review their controller training and checking standards to ensure that adequate emphasis continues to be given to the use of basic flight progress strip information.

2.23 The Christchurch controller had some preconceptions which may have hindered his perception of the problem from his radar display. These were that such a problem could not occur so close to the sector boundary without warning, and that Metros flew at lower levels than BAe 146 aircraft. The first preconception was undoubtedly based on good working practices, but it demonstrated a misplaced faith in the human performance capability of other controllers, and should have been dispelled by simulator exercises during his training. The second preconception would have been dismissed if he had read and understood the flight progress strips.

2.24 These preconceptions may have related to some extent to his low experience as a radar controller, and might have been dispelled normally with increasing experience. It is important, however, that controllers and their managers are alert to ideas which can develop into mindsets, with the potential to skew human responses illogically.

2.25 Earlier in the day the Taranaki sector had a second controller working as a planner, but the position had been closed before the incident, in line with procedures for light traffic. The assistance the planner would have given the controller included taking flight progress strips from the printer, organising them onto the board and anticipating any conflicts from them. If the planner had still been working on the position he should have been able to alert the controller to the conflict before separation was lost.

2.26 The ATC system essentially provided a radar control environment for these flights in class C controlled airspace. It was reasonable for the aircraft to be given airways clearances containing the same route and level, because any problem which might arise was not predictable until they had departed. If one occurred it would be a function of the order of departure of the aircraft, and of the interval between them. With a reasonable assurance of radar control, any developing conflict should be resolved within the dynamic flow of traffic, by the appropriate controller.

2.27 This traffic management philosophy is in line with other modern ATC systems, is well proven and permits good traffic flows, but relies on both the integrity of the equipment used and the consistent performance of the people operating the system. In this incident there was no significant shortcoming of any equipment. The problem originated with the two controllers in succession not perceiving the conflict situation, for a variety of reasons as discussed above. While Airways Corporation should be able to improve its quality control of basic controller methodology by attention to training and checking standards, the system will still rely on human performance, with its potential for occasional lapses.

2.28 The STCA facility will be an appropriate aid to controllers when it is installed, and will enhance the overall safety of the system by providing an automatic warning, predicting when aircraft paths may conflict for any reason, whether a result of an ATC lapse or a deviation by an aircraft. It will, however, depend on the integrity of the equipment, both the aircraft transponders and the radar computers, for its successful function. This incident provided all the circumstances for an STCA warning, had it been installed.

2.29 While an ATC system may be able to work efficiently and with a high level of reliability it is unlikely to be completely foolproof. It is appropriate, and good airmanship, that pilots should recognise this and try to maintain situational awareness of other traffic, where possible, by whatever means are available. TCAS equipment has the potential to assist in this, even where it generates no warnings.

3. Findings

Findings and any safety recommendations are listed in order of development and not in order of priority.

3.1 The controllers involved were properly qualified and fit for duty.

3.2 The aircraft involved were being flown in accordance with the ATC clearances issued.

3.3 The clearances issued resulted in one aircraft overtaking the other on the same track and at the same flight level.

3.4 The aircraft crews did not have access to sufficient information to achieve situational awareness of other traffic.

3.5 The aircraft were under radar control at the time.

3.6 Normal radar control instructions to maintain separation between the aircraft were not issued by either air traffic controller involved.

3.7 The Auckland Area controller had normal and timely information available about the flight paths and times of the aircraft.

3.8 The Christchurch Area controller did not receive verbal co-ordination information from the Auckland controller about the aircraft. His other information was normal and timely.

3.9 Neither controller perceived the approaching conflict between the two aircraft.

3.10 Shortcomings in the use of flight progress strip and radar information were common to both controllers.

3.11 An STCA facility on the radar computer system could have alerted either controller in time for appropriate action to avert the conflict.

3.12 TCAS equipment in either aircraft could have alerted the aircraft crew in time for appropriate action.

4. Safety Actions

4.1 After this incident an Airways Corporation local unit order was issued in the Auckland Area Control Centre, to delay the issuing of contact instructions until aircraft are closer to the boundary of the next controlling authority.

4.2 Ansett New Zealand advised that they will fit TCAS equipment to all their aircraft as soon as practicable.

5. Safety Recommendations

The following safety recommendations were finalised, and responses received, after the approval date of this report.

5.1 On 11 June 1998 the Commission recommended to the Director of Civil Aviation that he:

5.1.1 consider the reintroduction of position reports by the aircraft crew on first contact with each ATC unit, (024/98); and

5.1.2 expedite the process of making rules for the carriage and use of TCAS by appropriate aircraft. (025/98)

5.2 On 23 June 1998 the Director of Civil Aviation responded as follows:

5.2.1 Your safety recommendations will be introduced into the CAA's rule making and consultative process and subject to the normal processes, including a cost benefit analysis. The outcome of these processes cannot be forecast at this point.

The CAA believes it is important to act to prevent the repetition of occurrences of this and similar types by the provision of remedies to systemic deficiencies.

In the absence of any information as to whether any safety recommendations have been made to any other party, the CAA view is that recommendations 024 and 025/98 are in the nature of 'final defences' should such a series of events again produce a similar situation. As such, they cannot be considered as a complete solution to the problem(s) that allowed the occurrence to take place.

The CAA has identified a number of systemic failures within the organisation which was responsible for ensuring safe separation of the aircraft and which failed to do so. The CAA has addressed these failures with that organisation in an endeavour to prevent a similar situation occurring again.

5.3 On 15 June 1998 the Commission recommended to the Chief Executive of the Airways Corporation that he:

5.3.1 review their controller training and checking standards to ensure that adequate emphasis continues to be given to the use of basic flight progress strip information. (026/98)

5.4 On 24 June 1998 the Manager for System Safety responded as follows:

5.4.1 The safety recommendation has been adopted.

A review was carried out and formal training and checking procedures were incorporated into the National Training Plan on 31 May 1998.

New controllers will receive the training prior to qualification and all existing controller to whom it is relevant will receive the training in one of their routine cyclical training sessions.

Report approved for publication 10 June 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
CDI	course deviation indicator
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
ETA	estimated time of arrival
ETD	estimated time of departure
^{o}F	degrees Fahrenheit
FAA	Federal Aviation Administration (United States)
FL	flight level
g	acceleration due to gravity
GPS	Global positioning system
HF	high frequency (3000 to 30 000 kHz)
hPa	hectoPascal
HSI	horizontal situation indicator
IAS	indicated airspeed
IFR	Instrument Flight Rules
IGE	in ground effect
ILS	instrument landing system
IMC	instrument meteorological conditions
kg	kilogram(s)
kHz	kilohertz
KIAS	knots indicated airspeed
km	kilometre(s)

LAME	Licensed Aircraft Maintenance Engineer
LF	low frequency
LLZ	localiser
Ltd	Limited
m	metre(s)
M	Mach number (e.g. M1.2)
°M	degrees Magnetic
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 (300 to 3000 kHz)
MHz	megahertz
mm	millimetre(s)
N	north
NDB	non-directional radio beacon
nm	nautical mile
NOTAM	A notice containing information concerning the establishment, condition or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to personnel concerned with flight operations.
NTSB	National Transportation Safety Board (United States)
NZDT	New Zealand Daylight Time (UTC + 13 hours)
NZGA	New Zealand Gliding Association
NZMS	New Zealand Mapping Service map series number
NZST	New Zealand Standard Time (UTC + 12 hours)
OGE	out of ground effect
okta	eighth 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 an aerodrome
QNH	an altimeter subscale setting to obtain elevation above mean sea level
RCC	Rescue co-ordination centre
RNZAC	Royal New Zealand Aero Club
RNZAF	Royal New Zealand Air Force
rpm	revolutions per minute
RTF	radio telephone or radio telephony
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