Report 96-021

two Boeing 767-300 aircraft

BR 365 and NZ 31

loss of separation

Auckland Oceanic Control Area

17 December 1996

Abstract

At 1105 hours on Tuesday 17 December 1996, Air New Zealand flight NZ 31 from Auckland to Brisbane, requested a clearance to climb from flight level 350 to non-standard flight level 370, because of turbulence at flight level 350. The level change was authorised by air traffic control, and as the aircraft left flight level 350, the crew noticed the "contrails" of another aircraft above and levelled off. A traffic alert and collision avoidance system traffic advisory message was received at the same time, indicating that the vertical separation of the aircraft on passing was 1800 feet. The loss of separation had the potential for a collision.

The safety issues discussed are the procedure for the use of flight progress boards and the issuing of clearances for non-standard flight levels. Safety recommendations were made to the Chief Executive of the Airways Corporation of New Zealand and the Director of Civil Aviation on these issues.

Transport Accident Investigation Commission

Aircraft Incident Report 96-021

Aircraft type, flight number and registration:	Two Boeing 767-300, BR 365 and NZ 31, B-16603 and ZK-NCI
Number and type of engines:	Not relevant
Date and time:	17 December 1996, 1111 hours[1]
Location:	380 nm (approximately) north-west of Auckland Latitude: 34° 29.7' S Longitude: 167° 59.5' E
Type of flight:	Scheduled Air Transport
Persons on board:	Crew: BR 365: 11 NZ 31: 10 Passengers: BR 365: 181 NZ 31: 219
Injuries:	Nil
Nature of damage:	Nil
Investigator-in-Charge:	A J Buckingham/R Chippindale

[1] All times in this report are in NZST (UTC + 12 hours)

1. Factual Information

1.1 On Tuesday 17 December 1996, Air New Zealand flight NZ 31 took off from Auckland International Aerodrome at 1018 hours for Brisbane. The flight was cleared at flight level[2] (FL) 350 and reported routinely at ISROB reporting point (RP), 200 nm Auckland DME (distance measuring equipment) at 1051 hours.

1.2 Between ISROB RP and the next RP, AKMEV, the flight encountered moderate turbulence so the captain requested a level change to non-standard FL 370 to seek smoother conditions. The request was made at 1107.49 hours and clearance was received at 1109.20 hours.

1.3 Shortly after 1109.35 hours, NZ 31 commenced climbing to FL 370, and had just left FL 350 when the crew noticed the "contrails" of another aircraft directly overhead and discontinued the climb immediately at FL355 and called the Oceanic Controller. Simultaneously, a traffic alert and collision avoidance system (TCAS) traffic advisory was received, and the TCAS display showed an aircraft symbol going directly overhead in the opposite direction and a vertical separation between the two aircraft on passing to be 1800 feet.

1.4 The crew called the other aircraft on VHF but heard no reply. Subsequent inquiry to air traffic control established that the aircraft was EVA Air flight BR 365 (Brisbane to Auckland) at FL 370. At 1113.13 hours NZ 31 was requested to return to FL 350. At 1115.41 hours NZ 31 was re-cleared, "At AKMEV climb flight level 370."

Air Traffic Control

1.5 Both aircraft were operating in the Auckland Oceanic Control Area (OCA/A), under the control of the Auckland Oceanic Controller, who was responsible for providing safe separation between the aircraft in that area. For aircraft west of ISROB RP (outside 200 nm Auckland DME), communication between the aircraft and the controller was by high frequency (HF) radio, with messages relayed to and from each station by Auckland Radio, a facility located in the same building, but in a room separate from the Oceanic Control position.

1.6 The Auckland Oceanic Controller relied on a flight progress strip mounted on a strip holder and displayed on a flight progress board to record the progress of each aircraft for the time the aircraft were under his control. That was those aircraft which were between 200 nm from Auckland DME and the next flight information region on their track, in this case Brisbane.

1.7 The flight progress strip for an aircraft recorded the essential information relevant to that aircraft. Whenever the aircraft reported reaching an RP the controller moved the strip from a bay on the flight progress board representing the RP it had been approaching, to the bay for the next RP along the aircraft track.

1.8 The process of moving flight progress strips to the next RP, whenever an aircraft reported that it had arrived at a given RP, meant that in the case of aircraft flying in opposite directions along the same track the flight progress strips were moved past each other some time before the aircraft they were representing flew past each other.

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[2] A surface of constant atmospheric pressure which is related to a specific pressure datum of 1013 hPa and is separated from other such surfaces by specific pressure intervals i.e. the altimeter indication with a standard pressure setting of 1013 hPa.

1.9 Outbound from Auckland the RPs along the track concerned were ISROB, AKMEV and SARAP. Flight BR 365, en route from Brisbane to Auckland at FL 370, passed SARAP at 1034 hours and estimated passing AKMEV at 1102 hours. NZ 31 passed ISROB at 1050 hours and estimated passing AKMEV at 1118 hours. When NZ 31 reported at ISROB at 1050 hours its flight progress strip was moved to the bay for AKMEV RP. When BR 365 reported at AKMEV at 1102 hours its flight progress strip was moved to the bay for ISROB RP.

1.10 When, at 1106 hours, NZ 31 requested a climb to the non-standard (for east-west traffic) FL 370 the flight progress strips had been moved past each other but the aircraft had not passed. Had the controller realised that a potential conflict existed he would then (as is standard practice) have calculated the expected time of passing (ETP) and related any clearance for the lower aircraft to climb to that passing time.

1.11 Civil Aviation Safety Order, Section 4 Paragraph 4.3 states:

> 4.3 Cruising Levels
>
> 4.3.2 For flight within the Auckland Oceanic FIR, the Table of Cruising Level specified here under shall be complied with:

Magnetic track 000° clockwise to 179° Altitude or Flight Level		**Magnetic track 180° clockwise to 359° Altitude or Flight Level**	
IFR	VFR	IFR	VFR
FL 270	FL 275	FL 280	FL 285
FL 290	FL 300	FL 310	FL 320
FL 330	FL 340	FL 350	FL 360
FL 370	FL 380	FL 390	FL 400
etc.	etc.	etc.	etc.

1.12 The Aviation Information Publication New Zealand (NZAIP) Planning Manual - RAC page 66 states:

> Cruising Levels
>
> Within class A[3] airspace, ATC (air traffic control) will assign levels in accordance with the IFR table of cruising levels except when:
>
> Any IFR level issued to a VFR flight is a non-standard level.
>
> Cruising levels issued to controlled flights shall be assigned in accordance with the New Zealand FIR (flight information region) Table of Cruising Levels except when:
>
> - an emergency exists.
> - no alternative separation is available, or
> - flights are operating on one-way routes, or
> - a pilot request has been made because of icing, turbulence, or impaired operating performance.

These constraints are observed in the case of the OCA/A but are not applied in the adjoining Oceanic Control Areas.

[3] Airspace in the Auckland Oceanic FIR which is controlled airspace

1.13 The controller concerned was 32 years of age and was on the second day of a four day spell of duty. The incident occurred 2 hours and 9 minutes after the start of his shift and 29 minutes since his last break. His Class 3 medical certificate was valid to July 1998 and his next proficiency assessment was due on 2 February 1997. He had worked 15 shifts in the last 30 days, all involving work on the oceanic sector.

1.14 He had commenced his air traffic service training in 1983 and qualified in 1985. After three years in Napier he had transferred to Auckland Oceanic in 1987 where he was employed until February 1992. After an overseas secondment of four years he returned to Auckland Oceanic in May 1996.

1.15 The position occupied by the controller had the additional responsibility of radar control, which was normally the responsibility of another controller unless the work load permitted "de-manning". De-manning allowed the second controller to take a break but required that controller to be on call at short notice. When this incident occurred the second controller was contacted and reported to his position in two minutes twenty seconds.

1.16 In oceanic control the controllers were responsible for a combination of radar control, procedural control and an oceanic control system. This required them to monitor an HF radio log, a communications screen, a radar screen and a flight progress board. One controller was monitoring all of these facilities at the time of the incident as the position was de-manned.

1.17 Of direct relevance to the incident were the flight progress board and the HF log. The HF log provided the record of transmissions made to and from the aircraft under the procedural control based on the information displayed on the flight progress strips.

1.18 Although a wider span of attention was required for the one controller during de-manning periods he had ready access to assistance from the other controller and did not consider he was overloaded at the time of the incident.

1.19 He was familiar with the use of flight progress strips to effect procedural control in general and in connection with oceanic control in particular. He was familiar with the concept of the position of the strip indicating the next destination or RP for the aircraft it was representing and had used this system for a number of years. Despite this he was not proof against an illusion, inherent in the system, that the aircraft had passed each other when the flight progress strips were moved past each other on the flight progress board. This illusion was created by the standard practice of moving each strip to the position on the flight progress board which indicated the RP to which the aircraft was proceeding, as soon as it reported at the previous RP.

1.20 It was not until the controller was reading the HF air/ground log entry, "ANZ 31[4] ADVD ACFT (advised aircraft) JUST CAME OVER TOP OF US ABT (about) 2000 FT ABV (feet above) HES NOW BEHIND" that he realised the aircraft had not passed each other.

4 When calling air traffic control the pilot, as is normal practice, prefaced the flight number with an abbreviation of the operator's name, e.g. New Zealand 31 and EVA 365. The full flight numbers however were NZ 31 and BR 365 respectively.

1.21 Auckland ATS Unit Orders page RAC 5-9 paragraph 6 dated 3 May 1996 stated:

> 6. FLIGHT PROGRESS STRIP ANNOTATION
>
> Flight progress strips are the only record of information/clearances passed between Controllers and aircraft that is consistently in front of the Oceanic Controller. It is essential therefore that data contained on the strip is pertinent, accurate and kept current
>
> > When passing clearances to airground operators, controllers shall; Enter the estimated time of passing, the separation times being applied, and the callsign of the relevant aircraft on the flight progress strip in boxes 6 and 7 .... ETP shall indicate the estimated time of passing, and SEP shall indicate the separation time being applied.

1.22 Neither the flight progress strip for NZ 31 nor that for BR 365 had an ETP entered on it. This was in accordance with standard practice as ETP was only calculated where a conflict could occur, for example, in a case such as this. Had the opposing traffic been recognised as such then an ETP would have been calculated to determine when it was safe for NZ 31 to climb to the non-standard FL which was already occupied by BR 365. When the controller first received each of the flight progress strips the aircraft were proceeding at standard flight levels and thus separated vertically by the standard 2000 feet. There was therefore no requirement for him to calculate the ETP. FL 350 for the aircraft flying to Brisbane and FL 370 for the aircraft coming from Brisbane were the standard FLs for the respective directions.

1.23 There is no computer monitoring to detect possible conflicts generated by clearances issued by the controller.

1.24 The active defences in place to minimise the potential of a loss of separation in the OCA/A were:

- the promulgation and enforcement of standard procedures,
- the training and recurrent examination of controllers,
- regulation of working hours and rostering to minimise fatigue,
- the provision of flight progress strips,
- the accuracy of aircraft navigation,
- the introduction of TCAS in some aircraft,
- the restrictions in the use of non-standard flight levels,
- the separation of flight levels assigned to aircraft above FL 290 by 2000 feet, and
- the use of standard flight levels for aircraft flying in opposite directions.

1.25 Latent factors which existed for the initiation of a loss of separation in the OCA/A were:

- the greater physical spread of the various displays the single controller had to monitor when their position was de-manned,
- the absence of any independent checking of the clearances which the controller issued (such as by a computer),
- the improvement in the accuracy of aircraft navigation by the use of inertial navigation and global positioning systems,
- the process of moving the flight progress strips to the next destination (or RP) for the aircraft as soon as it arrived at the previous RP, and
- the absence of pilot monitoring of the positions of other aircraft due to the minimum use of HF RTF as a result of the selcal system.

1.26 On 19 February 1997 The Sector Manager, International Air Traffic Services issued the following:

AUCKLAND OPERATIONS BULLETIN
NO. 07/97
DATE 19 February 1997

(Sector Affected OCA/R)

SUBJECT: GOOD OPERATING PRACTICE

Strip Handling when aircraft are on reciprocal tracks.

- Strips for both aircraft should be kept in the same bay until the aircraft have passed by the required separation.
- In most cases this will necessitate returning a strip to the bay for an RP already crossed, instead of moving it to the next bay. When doing this, the strip should be "cocked", and controllers should scan ahead along the route of flight, and detect any future conflicts.
- If there are future conflicts, the strips for the other aircraft should also be "cocked' until all conflicts are resolved.

2. Analysis

2.1 The circumstances of this incident had the potential for an in-flight collision which could have cost the lives of 421 persons. It is important therefore that the potential for such an accident is reduced to the minimum practicable, particularly as similar systems are in use in many parts of the world.

2.2 The controller was experienced, trained and tested to the required standards. He was well rested and operating at a time of light traffic flow. He had no history of similar incidents.

2.3 As there is no computer or other monitoring of clearances issued by the Oceanic Controller in the OCA/A and no pilot monitoring of HF transmissions from other aircraft, safe separation of aircraft is dependent upon the concept of the infallibility of the controller involved. The pilot of the EVA Air aircraft was unaware of the incident until after the completion of his flight, and the pilot of the Air New Zealand aircraft was not aware of the incorrect clearance for his climb until he saw the condensation trail of the higher aircraft and received a TCAS traffic advisory. This illustrates that pilots are unlikely to be aware of an unacceptable oceanic ATC clearance.

2.4 The controller was not aware of the impropriety of the clearance which he issued for the Air New Zealand aircraft to climb to the FL occupied by the EVA Air aircraft until he read the report from NZ 31 in the ATC HF log. This indicated that he would not have realised his mistake in time to prevent a close encounter between the two aircraft had they been in positions along their respective tracks which would have resulted in such a conflict.

2.5 The accuracy of the navigation systems in the Boeing 767 aircraft involved meant that had they been at the same FL there was a significant potential for a head-on collision. In this case however this potential would have been mitigated by the TCAS system with which each aircraft was fitted and the daylight visual meteorological conditions.

2.6 The oceanic control environment is intended to ensure safe separation of aircraft in the most adverse meteorological conditions at night and without a need for pilot lookout even in clear daylight. It is not dependent in any way upon the correct resolution of a collision potential by the pilot or equipment fitted to the aircraft such a TCAS or radar. The pilots' only responsibilities in respect of the air traffic control, to enable them to provide this separation, are to fly the approved flight plan accurately, to comply with any supplementary air traffic instructions when practicable and to make accurate position reports as required.

2.7 The most significant factor which led to this incident was the illusion that the aircraft had passed each other which was created by the physical crossing over of the flight progress strips on the flight progress board before the aircraft, which were represented by those strips, had passed each other.

2.8 While there are detailed instructions for the preparation of the flight progress strips and explanations of their purpose, there is a hiatus in the international and local references to the subject in relation to the number of strips to be used to monitor the progress of any flight, the procedure for movement of those strips on the flight progress board and the layout of the flight progress board.

2.9 The flight progress board differs from similar systems in use in other modes of transport in that the strip representing the aircraft is moved progressively from one destination to the next rather than being used to indicate the position in a track system which is obstructed by its presence. It was this practice which led the controller, despite years of operating the flight progress strips in the traditional air traffic service system, to believe that on this occasion the aircraft had passed each other before he issued the climb clearance.

2.10 It would appear that a study is warranted to determine the most ergonomically effective use of the flight progress strips to exploit their potential to provide back up information for unmonitored procedural control of aircraft. It is possible, but not necessarily practicable, to make provision for the flight progress strip to be positioned between its aircraft's most recent departure point and its next destination, with the appropriate direction of travel indicated on the strip by a prominent arrow. Such a system would reveal immediately if and when more than one aircraft was in the same section of track. If there were more, then this system would be more likely to alert the controller to ensure he would not create a conflict if he issued a new clearance.

2.11 Another avenue which could be explored is a requirement for the Oceanic Controller to calculate an ETP and separation before he authorises a non-standard flight level unless there is a clear bay between the flight progress strips to indicate the aircraft had definitely passed each other.

2.12 A local procedure has been introduced to warn controllers that aircraft have not passed each other on a section of track by cocking the strip when its aircraft arrives at an RP and placing the strip in the bay for that RP rather than moving it to the aircraft's next planned position. This procedure overcomes the creation of an illusion that the aircraft have passed as soon as the flight progress strips are moved past each other. A disadvantage is that cocking the strips is also used to alert controllers to other situations which require special attention.

2.13 Computer monitoring for any potential conflicts, initiated by clearances issued by Oceanic Controllers, is already planned. This should be an excellent backup and has the advantage of constant monitoring of the standard of clearances in addition to detecting obvious conflicts. However with such systems there is likely to be a contingency plan for reversion to manual operation. At such times it will be more important to have straightforward procedures to guard against the loss of the automatic detection of incorrect clearances than when no such system was in place.

2.14 The practice of de-manning was not a factor in this incident as the other controller would not have been involved in the issue of the authorisation for NZ 31 to climb to a non-standard level. De-manning is an international practice and assists in the most efficient matching of the available controllers to the varying traffic load.

2.15 The increased accuracy of aircraft navigation systems is about to be used to reduce lateral separation between aircraft to 30 nm. This improvement in accuracy greatly reduces the chance that an aircraft flying the level allocated to another on an opposite track will not collide because of the variations in accuracy of track keeping. The altitude measurement systems available have been improved in many aircraft to produce accuracy of less than plus or minus 100 feet at altitudes in excess of 30 000 feet. This system accuracy has provided a potential, already realised in trans-Atlantic flying, to halve existing vertical separation for crossing that ocean. Many of the aircraft using the routes in the Auckland Oceanic FIR meet the requirements of altitude keeping to the standards required for this reduced vertical separation, which is another factor which increases the risk of collision if aircraft are assigned to the same altitude on conflicting tracks.

2.16 Controllers can not be considered infallible. The absence of a check on any clearance issued by a single controller, which has the potential to end in a catastrophe, is a matter of concern. This will be mitigated by the computer monitoring system but in the interim the safety of separation is dependent upon the false premise that each controller in the system who issues such clearances must be infallible. With such a significant potential for loss of life in a single collision between aircraft with the passenger capacities commonly using the oceanic routes it may well be that clearances issued need some form of audit before they are issued, particularly those for aircraft to fly non-standard flight levels.

3. Findings

3.1 The controller was properly qualified for his responsibilities and fit for duty.

3.2 The de-manning of the oceanic position at the time of the incident was not a contributory factor.

3.3 The aircraft involved were being flown in accordance with the air traffic control clearances issued.

3.4 If the Air New Zealand aircraft had climbed as cleared, it would not have reached its assigned non-standard flight level until the aircraft travelling in the opposite direction had passed. Thus there was no potential for a collision in this particular incident.

3.5 The introduction, after the incident, of an amended procedure in the handling of flight progress strips was effective in removing an illusion for the controller that the aircraft represented had passed each other. However the procedure did not illustrate to the controller directly that a section of track was occupied.

3.6 There may be a significant advantage in redesigning the flight progress board so that the holders for the flight progress strips are positioned in a bay representing a section of track between RPs rather than in a bay representing the RPs at either end of that track. This would ensure the controller knows whether a section of track is obstructed in any circumstances.

3.7 The absence of specific instructions to define an international standard for the movement of flight progress strips during the course of the relevant aircraft flight should be addressed to remove the potential for the creation of situations similar to that which occurred in this incident.

3.8 Contemporary aircraft navigation systems have improved the accuracy of track and altitude keeping, escalating significantly the risk of collision which exists for aircraft which are assigned the same flight level and are flying the same nominal track but in opposite directions.

3.9 It may be appropriate for changes to clearances issued for oceanic flights, particularly those involving non-standard flight levels, to be audited by an independent controller prior to issue.

4. Safety Recommendations

4.1 It was recommended to the Chief Executive of the Airways Corporation of New Zealand that he:

4.1.1 Conduct an audit of, and modify as necessary, the existing flight monitoring system and associated procedures to ensure controllers are made aware of aircraft on conflicting tracks, particularly those aircraft flying in opposite directions on the same track, (053/97) and;

4.1.2 Include a section in Local Unit Orders specifying the manner in which flight progress strips should be moved to represent the progress of the relevant aircraft. (054/97)

4.2 The Chief Executive of the Airways Corporation responded as follows:

4.2.1 053/97
This audit is being planned and will be carried out in mid October 1997. Depending on the outcome of the audit and the complexities of any processes recommended it is expected that implementation of the audit recommendations will take place by 31 October 1997.

054/97
Interim changes to Local Unit Orders have already been implemented to address this recommendation. Final changes will be made, or existing ones confirmed, following the results of the audit arising out of recommendation 053/97.

4.3 It was recommended to the Director of Civil Aviation that he:

4.3.1 Not authorise any reduction in vertical or longitudinal separation minima in the Auckland FIR unless the positions of the aircraft involved can be monitored on an electronic situation display. (056/97)

18 August 1997

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
ARINC	Aeronautical Radio Incorporated
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)
ATT	attitude
AUTO	automatic
AUW	all-up weight
BITE	built-in test equipment
BSCU	brake system control unit
C	Centre
°C	degrees Celsius
CAA	Civil Aviation Authority
CASO	Civil Aviation Safety Order
CDI	course deviation indicator
CFI	Chief Flying Instructor
CMC	central maintenance computer
C of A	Certificate of Airworthiness
C of G (*or* CG)	centre of gravity
CPL (A *or* H)	Commercial Pilot Licence (Aeroplane *or* Helicopter)
DC	direct current
DME	distance measuring equipment
E	east
EICAS	engine indication and crew alerting system
EIU	electronic interface unit
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
HSI	horizontal situation indicator
HT	high tension
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
IRS	inertial reference system
IRU	inertial reference unit
kg	kilogram(s)
kHz	kilohertz
KIAS	knots indicated airspeed
km	kilometre(s)
kt	knot(s)
L	left
LAME	Licensed Aircraft Maintenance Engineer
lb	pound(s)
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
PFD	primary flight display
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
QRH	Quick Reference Handbook
R	right
RNZAC	Royal New Zealand Aero Club
RNZAF	Royal New Zealand Air Force
r.p.m.	revolutions per minute
RTF	radio telephone or radio telephony
s	second(s)
S	south
SB	service bulletin
SAR	Search and Rescue
SSR	secondary surveillance radar
^{o}T	degrees true
TACAN	Tactical Air Navigation aid
TAF	aerodrome forecast
TAS	true airspeed
TCAS	traffic alert and collision avoidance system
UHF	ultra high frequency
UTC	Co-ordinated Universal Time
V	volts
VASIS	visual approach slope indicator system
VFG	Visual Flight Guide
VFR	visual flight rules
VHF	very high frequency
VMC	visual meteorological conditions
VOR	VHF omni-directional radio range
VORTAC	VOR and TACAN combined
VTC	Visual Terminal Chart
W	west