No. 95-015

Cameron A-210 Hot Air Balloon

ZK-FAR

In The Sea Near North New Brighton, Christchurch

19 October 1995

Abstract

On Thursday 19 October 1995 at 0940 hours, Cameron A-210 balloon ZK-FAR, on a passenger scenic flight, was overtaken by a squall line, lifted and blown out to sea near North New Brighton, Christchurch. Three passengers were drowned. The rapid approach of the squall line and the pilot's non-observance of it because of preoccupation were factors in the accident. Safety issues addressed were the carriage of lifejackets, and procedures for approval of check pilots.

Transport Accident Investigation Commission

Aircraft Accident Report No. 95-015

Aircraft type, serial number and registration:	Cameron A-210 Hot Air Balloon, 2702, ZK-FAR
Year of manufacture:	1991
Date and time:	19 October 1995, 0940 hours*
Location:	In the sea near North New Brighton, Christchurch. Latitude: 43° 28.2' south Longitude: 172° 43.4' east
Type of flight:	Air Transport, Scenic
Persons on board:	Crew: 1 Passengers: 8
Injuries:	Crew: 1 nil Passengers: 3 fatal 5 nil
Nature of damage:	Substantial
Pilot in Command's Licence:	Commercial Pilot Licence (Balloon)
Pilot in Command's total flying experience:	325 hours (282 balloon flights)
Information source:	Transport Accident Investigation Commission field investigation
Investigator in Charge:	J J Goddard

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

1. Factual Information

1.1 During the afternoon of Wednesday 18 October 1995 the pilot of Cameron A-210 Hot Air Balloon ZK-FAR, who was also the Chief Executive of the balloon operating Company, had contacted his passengers to confirm their availability for the planned balloon flight early on the following morning, and to advise that he would wake them by telephone at 0500 hours if the weather was suitable.

1.2 At 0430 hours on 19 October 1995 he checked the local weather by using his computer to obtain half-hourly reports from a local automatic weather station, and by observation outside. From the general weather forecast on television the previous evening he was expecting the passage of a cold front during the night with dying southerly winds in the morning.

1.3 He concluded from these reports, and his observations, that the front had passed over and that the light rain then falling would clear, with the weather conditions likely to be suitable for the flight if it was delayed by about an hour and a half. Company balloon flights were normally arranged to commence between dawn and sunrise.

1.4 The passengers were picked up at 0730 hours by the pilot and his ground crew, with the Company van and the balloon on its trailer. At their rendezvous point in Christchurch the pilot released a helium-filled pilot balloon, to assess the local winds in order to select an appropriate launch site for the conditions. The Company had several alternative launch sites, to provide for a one-hour flight in differing winds.

1.5 The path of the pilot balloon indicated a light south-westerly wind, which favoured launching from Burnside, on the north-west side of the city, so they proceeded to that site to prepare for the flight. At Burnside, however, a second pilot balloon ascent indicated a local south-east wind which would cause the balloon to fly close to or over Christchurch Airport. As a result the pilot decided to return to Christchurch, and to launch from Hagley Park.

1.6 At Hagley Park a further pilot balloon ascent indicated light southerly winds which would be suitable for a one hour flight.

1.7 ZK-FAR which was a large balloon, (210,000 cubic feet), was prepared, and then launched from North Hagley Park at 0834 hours without incident. It had sufficient fuel for two and a half hours flying. The flight proceeded normally, drifting initially to the north, then north-east, at an altitude of up to 1600 feet. By 0931 hours it had travelled some four nautical miles, in clear sunny conditions.

1.8 During the progress of the flight the pilot decided that a landing in the Marshlands or Travis Swamp areas of open rural land to the north-east of Christchurch would be feasible. As they approached Travis Swamp the pilot discussed this with his ground crew below by RTF. They considered that the ground would be too wet, after overnight rain, to permit vehicle access to recover the balloon. Because of this the pilot decided to continue the flight, intending to land on Ascot Golf Course about half a nautical mile away.

1.9 At about this time, one of the passengers mentioned to the pilot that he had noticed some dark clouds behind them. The pilot, who was concentrating on his landing approach, glanced behind and noticed some dark clouds to the south-west which he estimated to be at least 10 km away. These clouds did not give rise to immediate concern, and he focused his attention on landing the balloon.

1.10 The balloon was accordingly flown on an approach to land on this golf course, one nautical mile from the sea, and was at about 150 feet agl on final approach, in a controlled descent, when it started ascending without the pilot using the burners to supply heat. As it climbed rapidly through about 500 feet, the pilot saw for the first time a large dark wall of cloud which was approaching quickly on the right of the balloon's path, from the south-east.

1.11 The ground crewman had arrived at Ascot Golf Course and was watching the balloon's approach to land when he noticed the wind suddenly freshen from the south, and first saw the line of black cloud. He promptly radioed a warning to the balloon pilot, but the balloon was already being lifted by the approaching weather.

1.12 The balloon's involuntary climb continued up to 1600 feet, at about 600 feet per minute. Near the top of the climb the pilot vented the balloon for a couple of seconds, using the parachute valve, to arrest the climb and recommence the descent. The pilot was aware that the envelope temperature was low after not burning for some three minutes, so he selected the cross-flow valves "ON" to enable all four burners to be activated, in anticipation of a high descent rate developing. He was able to moderate the descent with the use of two burners, however.

1.13 Shortly after the climb started, the balloon began drifting much more rapidly to the north, with a 60° change from its previous track. The pilot tried to descend the balloon to make a landing before it crossed the shoreline, but when it became apparent that this was not possible and that they would land in the sea he alerted his passengers to the water landing, checked that they could swim, and instructed them to take their landing positions.

1.14 The pilot was able to further reduce the balloon's rapid descent for landing by using two burners, then turned off the pilot lights. The landing was firm, with 200 to 300 feet per minute descent rate, and at an estimated 20 knots across the water. The touchdown was about 200m offshore, but the balloon was blown further out before deflation was complete. When the basket of the balloon tipped over after landing several passengers were thrown into the water. The pilot checked that all the passengers had got into the water and were clear of the balloon, and told them to start swimming towards the beach.

1.15 Several witnesses had seen the balloon approaching the coast, and also the approaching black cloud. When it seemed inevitable to them that the balloon would land in the sea they initiated notification of the Police and ambulance services.

1.16 One of the people notified was a local fisherman at North New Brighton, some two nautical miles south of the accident site, who had just returned from fishing. With his crewman he quickly relaunched his boat and sped to the scene in difficult conditions. They recovered six passengers from the sea, then the pilot from the basket, delivering them to the nearby shore by 1000 hours, where Police and ambulance units had by then assembled. First aid and resuscitation was promptly administered, as appropriate, but one passenger was unable to be revived. The survivors were transferred to hospital and released later that day.

1.17 The search for the two other occupants was continued by the fishing boat, and by helicopters, but without success. Their bodies were found on the beach to the north after the next tide.

1.18 None of the survivors had been able to swim to shore. Several reported difficulty in staying afloat in the conditions. The water temperature was 10° Celsius, and the sea surface was choppy in the strong southerly wind. Rain and sleet fell, with a marked drop in air temperature as the weather change occurred.

1.19 The balloon was not equipped with lifejackets. Civil Aviation Regulation 104(v) required their carriage when it was engaged in overwater operations.

1.20 Examination of the balloon disclosed no pre-accident defects or failures. It had been properly rigged before flight. The envelope was torn, reportedly by the strong wind on landing. Other damage was consistent with its recovery from the sea. The four fuel tanks contained sufficient LPG for a further 90 minutes flight at the balloon's laden weight, which was well below the maximum permitted for the ambient temperature. The balloon had a valid Maintenance Release and Certificate of Airworthiness. It had flown a total of 283 hours since new.

1.21 Since the flight was within the Christchurch CTR it was being operated on an ATC clearance from Christchurch Tower. Normal RTF communications had taken place between the pilot and Christchurch Tower.

1.22 The balloon was equipped with a mode "C" transponder, and a plot of the recorded ATC radar data was obtained from Airways Corporation. The SSR plot showed the balloon's progress from Hagley Park towards the north, then north-east, at an average groundspeed of four knots until the vicinity of Ascot Golf Club at 1934 hours. At that point it had started climbing and moving north at a groundspeed of 18 knots, then descending some three minutes later to end at sea-level at 0940 hours.

1.23 The weather situation on 19 October 1995 was that an anticyclone covered most of the Tasman Sea, with a south-west airflow over South Island. A cold front in this flow passed over Christchurch at about 0100 hours, and by 0600 hours was over Cook Strait.

1.24 Public forecasts for the area were for south-west winds with the possibility of a few showers; the showers clearing and winds easing to a fine sunny day. The marine forecast for Pegasus was for:

> "south-west 25 knots, easing to 15 knots this morning ..... a few showers with poor visibility, clearing during the morning".

1.25 The TAF for Christchurch Airport, issued at 0531, valid 0400 to 1700 hours, was:

> wind 220° at 8 knots, visibility 30 km, 3 octas cumulus 2500 feet, becoming 1300 to 1600 hours: 060° at 8 knots. 2000 foot wind: 200° at 18 knots, becoming 1300 to 1600 hours: 200° at 8 knots.

1.26 This TAF was revised at 0945, valid 0900 to 2400 hours, to:

> wind 220° at 8 knots, visibility 30 km, rain showers, 2 octas cumulus at 2500 feet, 3 octas stratocumulus at 4000 feet.
>
> Temporarily between 1000 and 1200 hours: 200° at 15, gusts 25 knots, visibility 6000m, rain showers. Becoming 1800 to 2100 hours: 040° at 6 knots. 2000 foot wind: 210° at 20 knots, becoming 1800 to 2100 hours: variable at 5 knots.

1.27 A report by MetService on the weather at the time of the accident commented that this type of weather system (the squall line) is primarily a small or mesoscale feature and as such almost impossible to forecast more than three to six hours ahead because the network of surface observations is generally too coarse to describe them adequately. The primary aid to their detection and subsequent forecasting is radar. However this particular squall gave no indication of unusual surface winds from early observations or radar, and it is doubtful whether the pilot of the balloon would have been given an accurate forecast even one hour before the accident. A more active squall line would have been easier to forecast.

1.28 The automatic weather station at Timaru recorded the passage of the cold front at 2300 hours, then light and variable winds until the squall line passage at between 0800 and 0900 hours. This produced a southerly wind of 12 knots gusting to 21 knots, but no rain.

1.29 The automatic weather station at Le Bons Bay, which is at 800 feet amsl on Banks Peninsula, recorded the cold front at 0100 hours, then southerly winds of 21 to 26 knots with occasional rain, until the squall line passage at between 0800 and 0900 hours, when the southerly increased to 34 knots.

1.30 Observers in Christchurch, Lyttelton and New Brighton reported seeing the approaching line of cloud after about 0900 hours, commenting on its rapid movement, darkness and activity. Roll cloud and a waterspout were mentioned.

1.31 Anemograph records from various locations were studied to establish the progress of the squall line. These showed the onset of the squall at 0915 hours in Halswell, 0929 in Christchurch City, 0930 at Canterbury University, 0920 to 0930 at Christchurch Estuary and 0930 to 0940 hours at North Beach. The resolution of the records precluded establishing the local speed of the squall line, however.

1.32 The MetService weather radar at Rakaia showed the squall line by returns from associated cloud activity. At 0846 hours it was lying along the Canterbury coast south of Rakaia to Akaroa. At 0947 hours it had moved to just north of Christchurch and North New Brighton, inferring that it was moving at 30 to 35 knots.

1.33 Photographs of the squall line taken at about the time of the accident showed the cloud activity and precipitation to be most severe along the coast, with a marked roll cloud leading, while a few miles inland it petered out to a line of small cumulus clouds.

1.34 The pilot stated that during the flight, from the approach to Travis Swamp onwards, he was concerned with his approach and landing, and picking a site. As a result he did not look around at that stage and so did not observe the line of dark cloud on his right.

1.35 The balloon operating company records showed that the pilot had not had a flight competency check in accordance with Civil Aviation Regulation 76, as required by the Operations Manual. Further enquiry showed that the same situation applied to the other company pilots, and also to other commercial balloon operators throughout the country. This situation had arisen because no check pilots had been approved for balloon operations by CAA.

1.36 The Company had made application to CAA for approval as a check and training organisation under Civil Aviation Regulation 191 in December 1993, in order to conduct Regulation 76 checks. Correspondence from CAA during 1994 indicated procedural difficulties because of non-balloon-specific legislation in CASO 1, and also the pending transition to Civil Aviation Rules.

1.37 The Chief Pilot did carry out monitoring of the other company pilots when their balloons were being operated together as a group, and operational procedures were addressed at pilot meetings.

2. Analysis

2.1 This accident involved the effects of a small-scale but dramatic weather change which was not anticipated by the pilot of the balloon. Two aspects of this are considered: the events after the weather overtook the balloon, and the information available and action taken both before and during the flight in respect of the pilot's planning and decision-making tasks.

2.2 The balloon was on final approach to land at the end of a fairly typical one-hour scenic flight when it was overtaken by the outflow and rising air ahead of a squall line which approached quickly from the south. Any balloon, as a result of its aerostatic nature, is susceptible to movement, or changes to movement, in its surrounding air. In this case, although the balloon was in a steady descent, it was lifted up to 1600 feet in three minutes, in spite of the pilot refraining from heating the balloon. This action, of allowing the balloon to cool, would normally result in a rapid descent, up to 1000 fpm, in still air over such a period. The climb to 1600 feet thus indicates the significant air movement involved.

2.3 The pilot vented the balloon towards the top of its climb, to help arrest the climb and recommence the descent. While this action could have been taken sooner, and might have reduced the overall effect of the squall uplift, it would have been imprudent to vent a balloon of this large size (210 000 cubic feet) while it was much closer to the ground. This was because there was no way of knowing how high the rising air would extend, and if the balloon had started its rapid descent from a lower altitude it might not have been possible to check the descent before striking the ground in a hard and involuntary landing.

2.4 After the balloon had stopped being lifted, and was obviously being carried along towards the sea at a much greater speed than hitherto, the pilot had to control its descent to try to land in the remaining space available. This required a rapid descent, which was bound to ensue anyway, but it also required heating the balloon to reduce its descent to a tolerable rate for the landing. The radar evidence showed that the descent from 1600 feet to sea level took three minutes, which was expeditious; a shorter time was unlikely to be achieved with a moderate rate of descent on arrival. The pilot's handling of the balloon was competent and probably appropriate for the circumstances.

2.5 The descent path of the balloon, determined by the wind, was unfortunately such that a landing before the shoreline could not be achieved. The pilot decided to continue to descend, to land as close to shore as possible. He expected that the sea conditions would permit the occupants to swim ashore from where they would land; he checked that they could swim with this in mind.

2.6 As it turned out, the cold sea temperature and choppy water surface precluded anyone from swimming very far, whatever swimming ability was possessed. The prompt and meritorious rescue by the local fisherman and crew was fortunate, as the survivors were severely chilled, and not likely to remain afloat for more than a few minutes longer when rescued.

2.7 The drownings probably resulted from cold temperature effects on blood circulation to the victims' muscles, leading to an inability to maintain sufficient swimming activity to keep their heads above water.

2.8 The balloon had some 90 minutes fuel endurance remaining, and thus was not obliged to land immediately. The pilot could have kept it airborne, perhaps with difficulty in the rain and hail which followed, and alerted search and rescue by RTF before landing. Such help, to be effective, would have needed to provide winch-equipped helicopters with a capacity of nine people, at the site before ditching out to sea. The speed of the balloon would have made it difficult to pursue by boat. There was a remote alternative chance that the track of the balloon would have taken it back over land on the other side of Pegasus Bay before its fuel was exhausted.

2.9 Consideration of the unknown aspects involved if the pilot had decided to keep the balloon airborne, which included the availability of helicopters, the sea state out to sea, and whether continued flight would have been possible in the bad weather, leads to the conclusion that landing as close inshore as possible was probably the better option.

2.10 Lifejackets could have greatly increased the chances of survival in this accident. While they would not have altered the onset of hypothermia, they would have prevented premature drowning as body cooling reduced swimming ability. It would be appropriate for the Balloon Association of New Zealand to consider and make suitable rules for the carriage of lifejackets in passenger carrying balloons.

2.11 It was worthy of note that the basket remained afloat, probably supported by the buoyancy of the fuel tanks. In a similar situation where swimming to shore was deemed not a suitable option, the occupants might well be advised to hang on to the basket for support.

2.12 The public weather forecasts which the pilot considered in planning his flight led him to expect that some suitable weather might occur after the passage of the cold front, depending on its timing. In the event, the timing of the clearance behind the front gave rise to the decision to fly about one and a half hours later than usual.

2.13 These forecasts did indicate the possibility of a few showers. This is not unusual in the air mass behind a cold front, and is indicative of moderately deep instability which can give rise to towering cumulus or cumulonimbus clouds from convective activity. The coalescence of such activity into the band of weather which generated the squall line was not suggested by any forecast, however. The report from MetService essentially stated that it was not generally practicable to forecast such a small scale weather system. It was noted that the Christchurch Airport TAF was amended to incorporate its effects only after the squall line had passed Christchurch.

2.14 Such a weather system, however, is usually heralded by visible cloud development. This was certainly the case in this event, from the reports and photographs of an imposing line of dark storm clouds approaching from the south.

2.15 The speed of approach of the clouds was remarked upon by observers, and weather radar evidence suggested a speed of 30 to 35 knots. It was probable that the pilot of the balloon was preoccupied with finding his landing site for some 10 or 12 minutes, the elapsed time at four knots between commencing his approach at Travis Swamp and reaching Ascot Golf Course. During this time he did not look round to spot the approaching cloud, and its arrival surprised him.

2.16 The line of cloud probably moved some six nautical miles over this period of 10 or 12 minutes. Because of this, when he had last looked around earlier in the flight the clouds may have been seen as remote, and not perceived as an imminent threat to the balloon flight.

2.17 All forms of aviation activity do require that the crew remains alert for any signs of significant weather. This is particularly true for balloonists, because almost any weather is significant to their aircraft. In addition, their only course of action available may be a prompt landing when posed a threat from weather - they cannot fly away from it. Therefore balloonists, in spite of the leisurely progress of their aircraft, cannot afford to be preoccupied for so long, to the detriment of their weather watch. A further inference is that active cloud at a distance of five or even 10 nautical miles may pose a threat, not only because of its speed of approach, but because invisible air movement may occur at a substantial distance ahead of it.

2.18 The pilot's pre-flight assessment of the local weather, from local weather reports, his observation and interpretation of pilot balloon ascents was evidently quite accurate, until the arrival of the squall line. This was because his flight had proceeded from his chosen launch site to the intended area of landing in one hour, as planned.

2.19 The usual practice of conducting balloon flights early in the day, at or before sunrise, is to avoid the turbulence, up and down draughts and winds created by solar heating. The pilot's decision to proceed after a one and a half hour delay was probably approaching the maximum acceptable, because significant surface heating can occur by then, in mid-October, to cause convection to start. There was no evidence, however, that the activity of the squall line was influenced by this effect.

2.20 In summary, the pilot's planning and decision-making was appropriate. It was in line with the Company's normal procedures, and in normal circumstances would have provided adequate operational margins to maintain reasonable safety. The pilot's preoccupation with the approach and landing, leading to his non-observation of the squall line, together with its unusually rapid onset, were the main factors leading to this accident.

2.21 The shortcomings in the Company procedures which had led to its pilots not being flight checked as required by its Operations Manual were unfortunate, but not resulting from any specific acts or omissions by the Company. They were common to balloon operators throughout the country, and stemmed from the failure of CAA and operators to produce workable procedures to approve check pilots.

2.22 There was no indication that the Company's pilots had not maintained suitable levels of competency in balloon operations, and internal monitoring did provide some measure of quality control, but the generally widespread non-compliance with Civil Aviation Regulation 76 needed to be addressed by both CAA and balloon operators to assure the public that industry-wide standards were set and monitored.

3. Findings

3.1 The pilot was appropriately licensed and experienced for the flight.

3.2 The absence of the Regulation 76 check on the pilot's competency, required by CAA, was not a factor in the accident.

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

3.4 The balloon was properly fuelled and loaded.

3.5 The balloon was equipped in accordance with Civil Aviation Regulations for the intended flight.

3.6 The required equipment did not include lifejackets for the occupants.

3.7 The pre-flight planning and decision-making was appropriate for the intended flight.

3.8 The flight went largely as planned.

3.9 When on approach to land at the end of the flight, the balloon was overtaken by a rapidly moving squall line, lifted and blown out to sea before it could be landed.

3.10 The squall line was not forecast, and probably could not be forecast readily.

3.11 The squall line could have been seen and its effects probably anticipated in time to permit a prompt landing ahead of it.

3.12 The pilot did not see the squall line in time because he was preoccupied with landing the balloon.

3.13 The pilot's subsequent decision to land the balloon as close inshore as possible was appropriate.

3.14 The sea temperature and surface conditions made sustained swimming difficult and contributed to the drowning of three passengers.

3.15 The wearing of lifejackets could have prevented these drownings.

3.16 The timely rescue of the survivors by a local fisherman and crew was meritorious.

4. Safety Recommendations

4.1 It was recommended to the Balloon Association of New Zealand that they:

> Consider and make suitable rules for the carriage of lifejackets in passenger carrying balloons, (006/96) and;
>
> Develop without delay procedures whereby CAA may approve suitable check pilots to conduct Regulation 76 checks. (016/96)

17 April 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)
°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